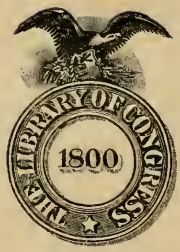


Class _____

Book _____

WALTER R. STEINER
COLLECTION

CANYON AND CRATER

OR

Scenes in California

AND THE

SANDWICH ISLANDS.

BY JOHN W. BOOKWALTER.

SPRINGFIELD, OHIO:
REPUBLIC PRINTING COMPANY, PUBLISHERS.
1874.

F866
.B7
copy 2

Entered According to Act of Congress in the year 1875, by
JOHN W. BOOKWALTER,
In the Office of the Librarian of Congress at Washington, D. C.

TO

MY BELOVED WIFE,

WHO, WITH HEROIC COURAGE AND DEVOTION, ACCOMPANIED US IN OUR JOURNEY, SHARING BOTH ITS

PLEASURES AND PERILS,

THIS VOLUME

IS AFFECTIONATELY INSCRIBED

BY THE

AUTHOR.

BEQUEST OF
DR. WALTER R. STEINER
JAN. 20 1948

PREFACE.

The tour of which this volume is an imperfect record was originally undertaken with a view chiefly to the restoration of the author's health; and in that respect, if in no other, it proved a gratifying success. In no quarter of the globe can there be found a climate more friendly to the human constitution than that of California and the Sandwich Islands. Of the two localities, the latter is entitled to the preference; and the only drawback upon its attractions is the long sea-voyage which the impatient traveler must endure before reaching the haven of his anticipations.

Of the *personnel* of the party, it may at least be said that whatever it lacked in numbers was fully made up in harmony and enthusiasm. The individuals composing it were Prof. H. R. Geiger of Wittenberg College, Springfield, Ohio, the wife of the writer, and the last-mentioned personage himself. And it is proper in this connection to state that Prof. Geiger's companionable qualities, and the zeal and fortitude with which he engaged in our many fatiguing excursions, contributed very largely to the enjoyment of the tour.

The account of our journey comprised in the following chapters was not written with a view to publication in this manner; nor is this volume designed for general circulation, but rather as a means of preserving to the author and conveying to his friends in a durable form the recollections of a somewhat

memorable experience. For the literary imperfections of the following pages it is scarcely necessary to apologize. They were written in fragmentary portions, and to a great extent in the haste and amid the inconveniences of land or ocean travel, without opportunity for correction or revision. The motive of their production, moreover, has not been that of an aspirant to the honors of authorship, but a desire on the part of the writer to revive in some degree, in their subsequent perusal, the impressions made upon his fellow-travelers and himself by scenes of beauty and sublimity which an abler pen than his could but faintly describe.

JOHN W. BOOKWALTER.

SPRINGFIELD, OHIO, 1874.

CONTENTS.

CHAP.		PAGE.
I.	Across the Plains and Over the Mountains	9
II.	The Humboldt Valley and the Sierras	24
III.	San Francisco	36
IV.	The Foot Hills of the Sierras	45
V.	The Calaveras and Mariposa Groves	52
VI.	En Route for the Valley	72
VII.	In the Valley	95
VIII.	From San Francisco to Honolulu	106
IX.	The Topography of the Pacific	121
X.	The Islands and their Inhabitants	143
XI.	Honolulu and its Environs	157
XII.	A Trip to Maui	189
XIII.	The Crater of Haleakala	215
XIV.	Hilo and its Vicinity	228
XV.	A Trip to the Crater of Kilauea	240
XVI.	The Eruptions of Mauna Loa	272
XVII.	The Origin of Volcanic Heat	299
XVIII.	Trip to the Crater of Mokuaweoweo	317
XIX.	Mud-Flow in Kau	332
XX.	Homeward Bound	351
Pronunciation of Hawaiian Terms		371

ILLUSTRATIONS.

1.	Sunset on the Platte Valley	11
2.	Salt Lake City and Wahsatch Mountains	17
3.	The Mormon Tabernacle, Salt Lake City	21
4.	Blue Canyon	25
5.	The Railway at Cape Horn	29
6.	Hydraulic Method of Mining	33
7.	The Sentinels	53
8.	Big Trees of Calaveras	57
9.	Dancing Party on Stump of Mammoth Tree	61
10.	The Fallen Monarch	65
11.	Descent into the Valley	69
12.	Indian Trail up the Mountain	73
13.	General View of the Yosemite Valley	77
14.	El Capitan	81
15.	Bridal Veil Fall	85

PAGE.

16. Nevada Fall 89
17. Yosemite Fall 93
18. The Professor's First "Specimen" 111
19. "Now You See It, and Now You Don't" 115
20. Map of the Sandwich Islands 123
21. Bottom of the Pacific 127
22. " " " " 131
23. Section of Sandwich Islands 135
24. View of Honolulu 156
25. Street Scene in Honolulu 159
26. Giant or Pulu Fern 166
27. The Taro Plant 169
28. Beating Poi 174
29. Eating Poi 177
30. View of Waikiki and Diamond Point 181
31. Surf-Bathing 185
32. Our Traveling Companions 190
33. That Schooner 192
34. Native Grass Hut 198
35. Scene on the Shore at Maui 206
36. View of Haleakala 214
37. Crater of Haleakala 218
38. Map of the Crater of Haleakala 222
39. View Across the Clouds 226
40. Forest Scene near Hilo 233
41. General View of Kilauea 243
42. Map of Kilauea 247
43. Sectional View of Kilauea 251
44. Crossing a Lava Field 255
45. Halemaumau, or Burning Lake 262
46. Map of Eruptions of Mauna Loa 279
47. Conduit from Mokuaweoweo to Kilauea 291
48. Crater of Mokuaweoweo 322
49. Survey of Mokuaweoweo 326
50. Mud-Flow in Kau 335
51. Sectional View of Mud-Flow 342
52. A Sulphur Bath 356

CANYON AND CRATER,

OR

Scenes in California

AND THE

Sandwich Islands.

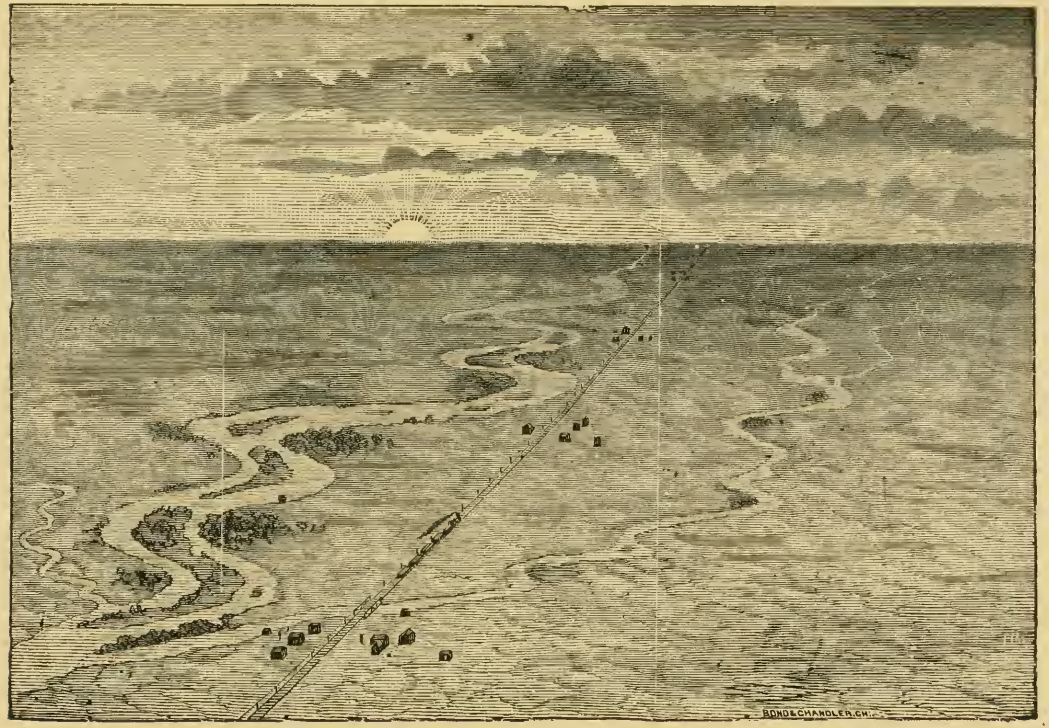
CHAPTER I.

Across the Plains and Over the Mountains.

"The Great West!" How few there are who really know the true significance of this oft-repeated phrase. Whatever may be its significance, I am sure it but feebly conveys an idea of the truly wonderful character of the yet undeveloped country that lies west of the Missouri River. It is here we find the developments of nature on its grandest and most imposing scale; and the uniformly vast proportions of all its operations constitute the distinctive feature of this country. It will of course be impossible for me to even glance at all the numberless objects of wonder abounding in this region, and I will therefore confine myself to

a brief notice of the more marked features of interest, qualified by what I may deem of value as well. As that part of our national domain lying east of the Missouri is no longer a new country, I select as a proper point of departure the western bank of that great river.

On taking the cars of the Union Pacific Railroad at Omaha, the country, for the space of a few miles, bears a very close resemblance to that of Iowa—beautifully undulating and covered with abundant verdure. But a complete change is suddenly wrought in the aspect of the country as the train abruptly plunges into the great valley of the Platte. So swift, indeed, is the transition, so great are the beauties that spread before the eye in all directions, that the change seems the work of enchantment. Ohio has its valleys of Scioto, of Miami and others not less cherished—Indiana its valley of the Wabash—but what are they in extent and fertility to the great Platte valley? By a valley, in Ohio or Indiana, is meant a tract of land extending in a broken line contiguous to the river, and of very limited width. The term, to those who have never seen the great valleys of Nebraska, would seem not inaptly applied; but they are mere bottoms, strictly



SUNSET ON THE PLATTE VALLEY.

speaking, and not valleys in the sense in which one is accustomed to view them in this country. Think of a valley extending for three hundred miles in an unbroken, uniform, level tract, and of an average width of nearly thirty miles; and some idea may be formed of the extent of this most wonderful valley that the sun shines upon. Wonderful as it would be by reason of its unusual area, it becomes a yet greater marvel when we reflect that it is of the highest grade of fertility.

Throughout its whole extent there is scarcely any waste land; and the entire tract exceeds, in point of fertility, anything I have seen in other sections of the country. It is peculiarly adapted to withstand the droughts which are so far the only drawbacks to Nebraska. There seems to underlie throughout the whole valley a sub-stratum of sand and gravel of great depth. Upon this is superimposed a deep, rich alluvial soil varying in depth from two to six feet. The soil is adapted to the production of almost all kinds of grain, as I had occasion to notice; corn, particularly, grows with singular luxuriance. The lands in this valley are as yet comparatively unoccupied, but are being rapidly settled up. It is a fine subject for

contemplation, as to what will be the future of this splendid valley—itself capable of supporting almost the entire population of the United States.

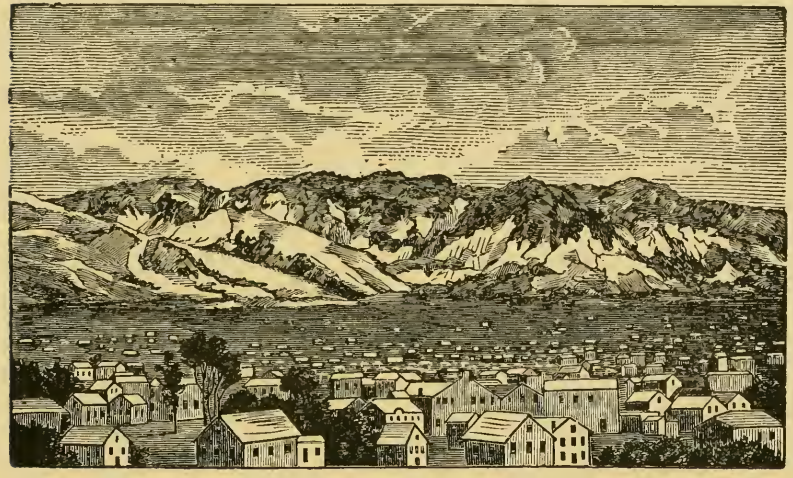
The Union Pacific Railroad has been much talked of, and many conflicting reports have been current as to the manner of its construction. Being desirous to ascertain as nearly as possible its real condition, I have from time to time made observations touching this point. The road-bed throughout its whole extent is most admirable, the soil being of such a nature as to admit of a very firm foundation; and I must say that I have never traveled upon any road so free from dust. The track for the first hundred or perhaps two hundred miles is laid of iron, the rails seeming to be of insufficient weight; and being without the fish-bar joint, they have become much worn and laminated, rendering the road quite rough. With this exception, I found rails of a weight and laid in a manner fully equal to any road in the East. The cars are principally of the Pullman pattern, and of course commodious, convenient and pleasant. Altogether there are few roads in the country more pleasant to travel upon than the Union Pacific Railroad.

After leaving the Platte valley, you bid adieu

to all attractive country, and enter upon the confines of a region whose sterility and barrenness is only heightened by contrast with the wonderful richness of the valley just passed through. By an easy, uniform grade through a distance of several hundred miles, the summit of the Rocky Mountain range is reached. By much the same grade, the descent of the western slope is made. One cannot fail to notice a marked difference in the geologic character of the Rocky Mountain range, compared with the Appalachian. Nowhere in the former are presented the rugged defiles and abrupt elevations, found in the latter. From this cause, the scenery of the Rocky Mountains, as seen from the cars, is much inferior to that of the Alleghanies. Much as has been said of the grand and imposing scenery immediately along the line of the Union Pacific road, I must confess I could not see it. The Weber and Echo canyons comprise, *par excellence*, the choice scenery on this road; yet to my mode of viewing, they cannot compare with the scenery where several railways cross the Alleghanies. There are indeed many distant views of mountain ranges that are really beautiful, particularly where they reveal the snow-capped peaks.

After a journey of fifty-four hours, we reach Salt Lake City—a city perhaps more talked of and written about than any other in the United States. It lies near the eastern edge of a valley which is almost completely encircled by a bold range of mountains, Great Salt Lake being twenty miles to the west of the city. Though made to literally blossom as the rose, Salt Lake valley bears traces of its once sterile character. In viewing the great improvements and changes wrought in this country, one is bound to accord the highest respect to the wonderful people by whose magic touch the primitive desert was transformed into blooming gardens and fertile fields. On all hands you will see orchards teeming with their luscious fruits, and broad farms covered with the products of the toil of these patient and skillful husbandmen.

Salt Lake City is regularly laid out, with streets of great width, along which trees are planted, forming beautiful avenues throughout the whole city. There are many really fine public buildings, and the Temple, now in process of erection, is designed to be one of the grandest church edifices in the country. One of the most striking features of Mormon society is the wonderful variety of



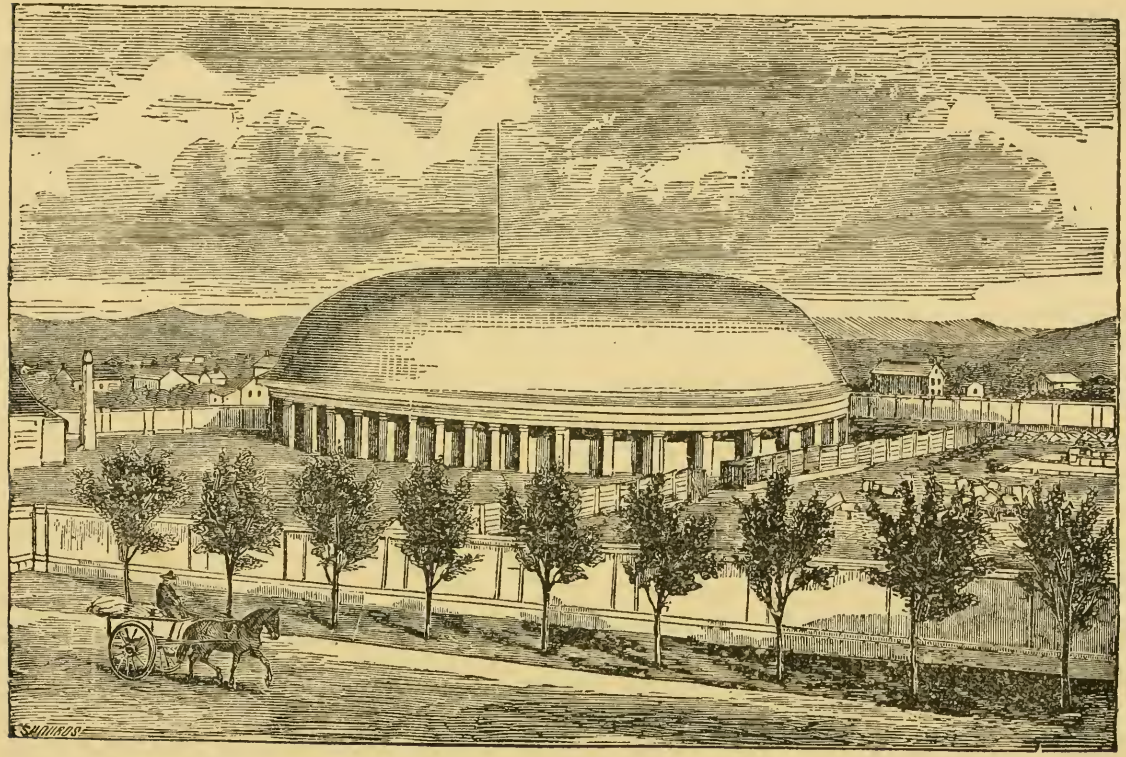
SALT LAKE CITY AND WAHSATCH MOUNTAINS.

character. Among this people are to be found men of all professions and crafts—artisans in every branch of industry, and of singular excellence. One is compelled to admire the skill which, without resources other than those developed within themselves, has erected buildings and produced works of art that will compare not unfavorably with those of an older and more favored community. In the Tabernacle, a large building devoted to Mormon worship, I found an organ which is said to be the second in size in the United States, of excellent construction and finish. Imagine my surprise when I was informed that it was entirely the work of these people—all the material entering into it being made, and the whole wrought together, by their own hands.

Just now the absorbing topic here is the silver mines which have so suddenly developed in this territory. On the cars, at the hotels and elsewhere, nothing is talked of but traces, leads, feet and other mining technicalities, to the unitiated a confounding jumble. Only eighteen months since the silver mines of Utah were almost unknown. To-day they take rank with the most productive ever yet discovered. While under the present excitement many wild rumors and extrav-

agant reports will of course be circulated concerning the new found treasures of Utah, yet when these are divested of all exaggeration we may safely say that so far as developed the Utah mines are far superior in point of richness and abundance of ore to any yet discovered in this country. While there are hundreds of mines whose existence is attested only by the mining records of the territory, and others daily being discovered, there are quite a number in actual operation, yielding most handsome returns. The most celebrated mine yet worked is the Emma, in what is called the Cottonwood district. The products of these mines are of a kind called the smelting ore. It is all shipped at present to Swansea, Wales, where it is worked up—a fact showing how exceedingly crude and imperfect are our facilities for the working of ore. The Emma Mining Co. are shipping to the above-named point about one hundred tons of ore per day.

The Eureka Mining Company of Utah have perhaps the most valuable and extensive claims in the territory, and are making rapid preparations to work up their ore. They have now on hand, ready for the mills, over five thou-



THE MORMON TABERNACLE, SALT LAKE CITY.

sand tons of ore, which will yield an average of over $100 per ton.

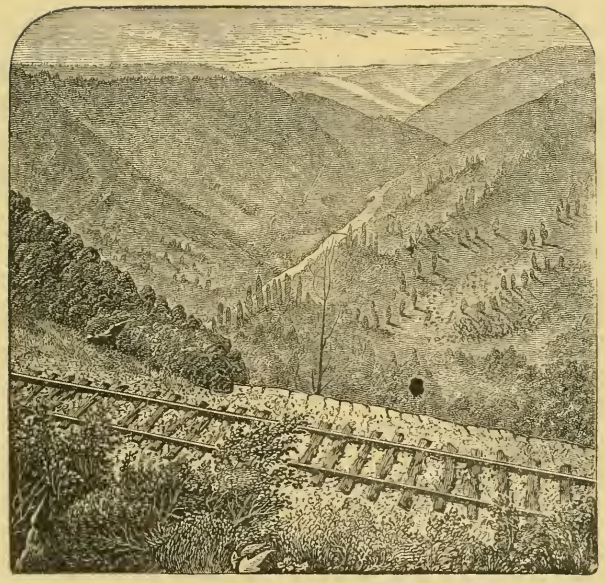
Rich and extensive as are the silver mines of Utah, they will perhaps afford in the future but a repetition of mining experiences in other districts. A few will make immense fortunes and many will be disappointed. Yet, judging from the richness of the ore and its accessibility as compared with other mining districts of the West, the future of mining in Utah must certainly be much more promising than any hitherto opened by similar discoveries.

While in the city I enjoyed a very pleasant interview with G. W. Cannon, editor of the Deseret News, the official organ of the Mormon Church. I found him a genial, pleasant gentleman, and learned of him many facts relating to the history of the country. The Deseret News is an enterprising, ably edited paper of large circulation, and celebrated as being the oldest paper west of the Missouri river.

CHAPTER II.

The Humboldt Valley and the Sierras.

Taking the cars of the Utah Central Railroad, we make immediate connection with the Central Pacific Railroad for the West at Ogden, which is temporarily the compromise junction of these two routes; and here, strange to say, an entire change, bag and baggage, has to be made by the worn and weary traveler who for the past three days has sweltered in the dust of Illinois and Iowa, the sands of Nebraska and the alkali of Wyoming. Whatever justification there may be, if indeed there can be any, for this singular want of co-operation between these two great companies, it is to be hoped, for the comfort of through passengers, that the day is not far distant when the difficulties existing may be so far adjusted as to permit at least a through car to make the entire trip from Omaha to San Francisco. But the ways of railroad corporations are peculiar, and beyond the ken of



BLUE CANYON.

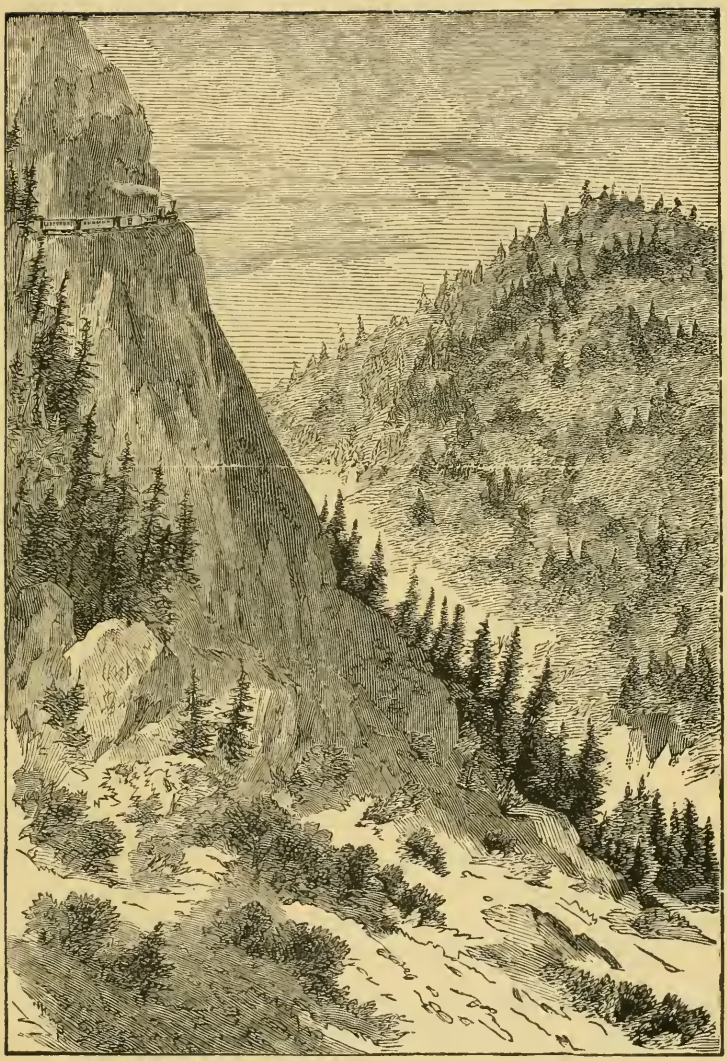
ordinary mortals; and whatever may be the considerations determining their action, it can hardly be said that the comfort of the traveling public enters into or modifies it.

Geographically speaking, the Central Pacific Railroad may be said to comprise three great divisions—that bisecting the great interior basin lying between the Rocky and Sierra Nevada mountains; the mountain pass of the Sierras; and the valleys of California—each division being peculiar and distinct in its geologic conformations, and every characteristic of surface and productions.

Through the eastern part of the interior basin, or what may be called the first division, there is nothing worthy of note to be seen, save occasional distant mountain views which are really fine, after which stretches on either hand a desert presenting to the view only desolation vast and illimitable—nothing but a dreary waste, unrelieved by anything that would gladden the eye or cheer the heart of the traveler, who each succeeding hour grows more weary of the dreadful monotony. To one accustomed to dense forests and prolific vegetation, these nude and desolate plains offer a most uninviting prospect. For several hundred miles the road follows, as to its general direction, the

valley of the Humboldt river—a stream hardly worthy the name of river. It is possessed of no interest except as affording an exception to the ordinary rule governing the growth of a river, which is, to increase in size as it increases in length. The contrary is the case with this strange river, which steadily decreases in size as it approaches its mouth; so that it not unfrequently entirely dries up long before it reaches its final destination in the Humboldt Lake—a body of water like the Great Salt Lake, apparently without an outlet. Such are some of the strange vagaries manifest in the works of nature in this marvellous region.

The pass of the railroad through the Sierra Nevadas is certainly a most wonderful achievement of modern engineering, and I believe not equaled in this country, if in any other. Whatever may be said of the tameness of the mountain scenery along the Union Pacific R. R., it most assuredly does not apply to that along the Central Pacific R. R. Throughout almost the whole descent of the western slope of the Sierras, the sublimity of the scenery is beyond description, and the most imposing views along the lines of eastern railroads shrink into comparative insignificance before the vast and terrific grandeur of this mountain range.



THE RAILWAY AT CAPE HORN.

Among the choice scenes in this region we may mention those of the Blue Canyon and Cape Horn, where the road winds along the towering hights of some of the loftiest peaks of this range. The awful spectacle of a railway threading its narrow path with scanty space around the tortuous curves of the summits of the Sierras, over 2,000 feet above their base, must be seen to realize its immensity. Language but feebly conveys an impression of it. I was at first somewhat surprised that no adequate description of this fine scenery has been widely spread; but I can well see that its overpowering grandeur must render mute the most fertile of speech and imagination. For the tourist and pleasure-seeker no finer trip can be found, and judging from the rapidly increasing travel over the road the fact is not only recognized but appreciated. There is much talk just now of an engineering enterprise which if consummated must rank as a peer of the Mont Cenis tunnel. Near the summit of the Sierras, and about 200 miles distant from San Francisco is the beautiful lake of Tahoe, celebrated as much for its purity of water as for the beauty of the surrounding scenery. The bold engineering feat of bringing the waters of this lake into the city has not only been conceived, but has

taken something of a tangible, practical form. In order to accomplish this, it will be necessary to tunnel the Sierras for a distance of nearly six miles —a work the magnitude of which can only be understood when the proposed route is examined. The enterprise was originally projected only for the purpose of supplying the city with pure water; but recently, I learn, the Union Pacific R. R. Co. have offered to contribute $1,000,000 towards the expense of excavating the tunnel so as to be of sufficient size to permit the passage of their trains through it. This arrangement would be of immense value to the road as a means of greatly shortening the distance and ridding it of the heavy expense of maintaining the miles of snow sheds which now encase the road from the summit to about half way down.

After leaving Colfax, the descent is through an easy grade, and the only objects of interest are the constantly succeeding mines, which are in this region carried on by the hydraulic method. This consists in bringing—sometimes from great distances—the waters of some mountain stream, to near the point where it is to be used, and conveying it in pipes similar to the hose employed by fire engines. As the head acquired is sometimes from

HYDRAULIC METHOD OF MINING.

400 to 600 feet, the water is discharged with tremendous force against the sides of the hills which contain the hidden treasure, and the denudation which follows is something surprising. Whole hills and mountains are made to literally melt away under the immense power of this eroding element, and the country for miles around shows traces of its effects, a perfect transformation of the whole face of the region being the result. By this method, claims that would yield but a beggarly reward to the toils of the miner by the ordinary process of working are made to return handsomely for the investment in ditches, sluices, pipes, &c., necessary to this method.

Many mines are now deserted, and show only the traces of their former busy occupancy by the miners, who have long since decamped for other and more profitable regions. As an illustration of the extreme frugality of the Chinese—who form a very large element of the population here—I am told that they frequently rework a deserted mine from which it was supposed that the Anglo-Saxon had extracted all its wealth, and by their patient persistence find among the well-worked debris sufficient of the precious metal to pay them for the toil bestowed.

CHAPTER III.

San Francisco.

With many an occasional flitting glimpse of the rich valleys of the Sacramento and San Joaquin far in the distance, we finally reach the foot of the Sierra Nevada range, and emerge into the rich valleys of California, the golden wealth of whose fruits and grains far exceeds that of its mountain regions. While passing through the great Sacramento valley, I beheld for the first time that celebrated optical phenomenon, the mirage; and a most wonderful sight it was. At the distance, as it appeared, of a mile, could be seen a lake, which seemed several miles across. The surface glistened with the rays of the sun, and was occasionally broken by the gentle ripple of apparent waves, with all the reality of a liquid lake. The reflection of objects that seemed to line its shores was lifelike, presenting the same inverted

appearance as seen on an actual lake, this reflection extending even to objects of small size. So perfect was the resemblance in all respects that I found it difficult to persuade myself that it was all an illusion. Yet there was no water within many miles of where the spectre was seen—nothing, in fact, but a level, dry, parched plain. The origin of the phenomenon is well known, and is possible only in an atmosphere of great purity and transparency, such as is found in this country. Nor is this the only proof of its purity, as its sanitary effect upon any one who has been long in this region will attest; the air having a rare buoyancy and vivifying power delightful to those accustomed to a murky atmosphere, and constituting one of the admirable characteristics of this region. One of the marked peculiarities of California that sensibly attract the attention of the traveler is its great diversity of climate, which ranges from the tropical to the frigid, and often in sections but a few miles apart. This is the result of the peculiar geographical constitution of the valleys, plains and mountain ranges, together with the powerful modifying influences of the oceanic and atmospheric currents which prevail on the coast. There being some thirty different valleys running parallel to-

wards the coast, each one of which has a climate peculiar to itself, the traveler is often astonished by the very sudden transitions of this nature which he experiences during even a single day's travel. The result of so great a variety of atmospheric conditions, together with almost an equal diversity of soil, is to give to California a variety of vegetable productions scarcely equaled by any country on the globe.

San Francisco, the great mart of the west, seems to be a natural outgrowth of these involved physical influences, and presents, as one might expect, the most multiform character. In fact, the city is a world of itself, and can never cease to be a source of astonishment to the traveler. Within its bounds you can find representatives of almost all nations, not as a loose floating element, but integrated into one common mass, forming as a whole the most heterogeneous combination ever embodied in a single community. English, Chinese, Spanish, French, and many other equally distinct nationalities are here jumbled together, each in the main preserving its peculiar customs and habits, but yielding so far to one common mode as to cement them into a social composite that is the delight of the ethnologist. Of the foreign element

the Chinese is by far the most numerous, and occupies in a central part of the city about twenty blocks, all in one body. A ramble among them constitutes one of the greatest novelties an American can enjoy. In company with a friend I visited, during the late hours of the night, the haunts of these busy little Orientals, and while I met with much to shock one's sensibilities, yet upon the whole the impression derived from a close observation of them was favorable. So well defined and marked are the limits of their occupation of the city, and so abruptly does one enter their quarters that if one were suddenly dropped into the heart of Hong Kong, the change could not be more startling. For long distances you can see nothing but a busy crowd of these people intently engaged in their various avocations or pastimes. Every little alley is utilized by them for shops or residences, and it is astonishing to see within what limited quarters they can not only live but make themselves even comfortable. There seems to be no branch of trade or of the arts to which these skillful people do not readily adapt themselves; and their industry is simply indefatigable. Their labors do not, as with the civilized Saxon, end with the day, but even at the hour of midnight the

streets and shops present the same busy, lively scene, as during the day. They have among other places of amusement a commodious theatre, wherein are represented what I suppose to be the choicest selections of the Chinese drama—to any but themselves the most complete bedlam. Nothing can exceed the weird scenes presented by the interior of a Chinese theatre. The unearthly sounds of the orchestra—which perhaps to the accustomed ear of the Chinaman is melody itself—the quaint dress and gestures of the players, and unique trappings of the stage, all combine to make up a scene that transcends the most startling effects of the Black Crook. To me it seemed that the whole merit of the play depended upon how complete a discord the orchestra could produce, and the degree of absurdity attained in the gyrations of the actors. To accomplish the former, the orchestra, with tom-toms, cymbals, and other squeaking and rattling instruments, made certainly a most vigorous and I may say successful effort.

Whatever of vice is contained in the Chinese character, lawlessness and disorder cannot be charged to them. "Oh," say their enemies, "they are heathen and brutal—low, sensual and animal."

But I must say that to see so many of these people compressed into small, narrow, dark alleys, and minutely subdivided rooms, as thick as the leaves of the trees, yet preserving the most perfect quiet and order, was to me indeed a wonder. Yet into the most secluded recesses of the gloomiest alley, surrounded on all hands by these people, I am told that one runs not the slightest personal risk, as assaults from them are unknown. Said the guide who accompanied me: "While you are perfectly safe among them, I am sorry to say that only two streets from here, among the haunts of civilized men, you are not safe, and would at the risk of your life make the same tour you have made among these heathen." So much for the degradation of the Chinese, and the perfect order of our boasted civilization. I am satisfied that no other race could be so crowded, within such narrow limits, and yet be guilty of so few infractions of the law as are these simple, mild and inoffensive people—certainly not the noble Celt or Anglo-Saxon.

Among the chief attractions here at present is the Mechanics' Fair now in progress, to which I paid a hasty, desultory visit. The Fair does great credit to the people of this State, and evinces an

enterprise scarcely inferior to that of their Eastern brethren. The building in which the fair is held is a large square edifice, centrally located, covering an entire block, convenient and commodious. The department of machinery was well represented, especially with native productions; but among the multitude on exhibition I found those familiar as of Eastern manufacture. Chief in this list was the celebrated Champion Reaper and Mower made in our city, which seems determined to conquer in this country as it has in the East.

There was an unusually large collection of paintings of rare excellence, evincing a taste for the artistic of the highest kind. In one end of the building was the largest and most beautiful collection of photographs I ever saw—and I doubt whether they have ever been equaled in this country, either for size or perfect accuracy of detail and finish. With full recognition of the skill of the artists who produced them, I must express my belief that their excellence depends much upon the peculiar clearness of the atmosphere of this country, which enables the much needed light to be obtained.

As might be expected, the horticultural department was of the most attractive and profuse na-

ture, affording such a display of fruits, vegetables and botanic productions as no other country can present. I have attended many of the finest expositions of the East, yet must confess for variety of display, convenience of arrangement, and as a whole, I have never seen so great a success as this. It is a subject of just pride to the citizens.

Business is now and has been for some time quite dull, a fact which the citizens are of course anxious to attribute to some temporary cause of derangement, but which it seems to me results from a serious, deep-seated and vital cause. In determining the probabilities of the future of any city, the real causes that develop its growth are the only sure and certain basis from which any prediction can be made. It must be evident that the past growth of San Francisco was wholly owing to the fact that it was a general distributing point for all kinds of supplies and equipments for the interior towns of the western territories and the entire coast, it being the only point from which such supplies could be obtained. Since the completion of the Pacific Railroad, a new inlet has been opened for trade with the interior towns, the result of which has been to bring other cities into competition with San Francisco in supplying those

sections, whose trade formerly belonged exclusively to this city. That the effect upon San Francisco of the building of the Pacific Railroad must be a detrimental one, a little observation will prove. At almost every town from San Francisco to Salt Lake, the observant traveler will see representatives from New York, Chicago and St. Louis firms drumming up a trade in those sections, all of which was formerly sent by them to San Francisco and there re-distributed by its citizens to the very same firms who now purchase direct from the dealer in the East. The effect of this diversion of trade cannot fail to be a serious one; and San Francisco will ere long perceive that her noble and cherished enterprise, while favorable to the growth of the State, was in a measure fatal to her own personal interests; and that after all the real gainer by this enterprise, as indeed by a majority of similar enterprises, is that great and grasping metropolis, the city of New York.

CHAPTER IV.

THE MAMMOTH TREES AND THE YOSEMITE.

The Foot-Hills of the Sierras.

After seeing the various objects of material interest in and about San Francisco, we bethought ourselves that the crowning glory of Californian natural scenery yet remained to be seen. So we resolved to brave the inevitable hardships intervening, especially as going home without visiting the Big Trees and the wonderful Yosemite would, by implication, confess our trip to have been made in vain.

Having beheld with our own eyes the surpassing beauties and grandeur of that enchanting valley, we of course must do as every one else has done who has been similarly blessed—commit our observations and experience to writing, regardless of the fact that it has been done hundreds of times before, and that the whole subject, at the hands of the *litterateur* and artist, has become trite and

threadbare, and every object of novelty and beauty as carefully extracted as the precious metal from some super-worked placer. But how to reach the valley with the smallest amount of fatigue is really an important problem, and as difficult for the stranger to solve as it is important.

Preparatory to a trip fraught with such varied experiences of pleasure and pain, we consulted every available map of California, talked big tree and Yosemite to any one who would patiently suffer the infliction, badgered the returned tourist, and listened, at first with beaming delight, to a host of solicitors for various competing routes, as each recited the superior attractions and advantages secured by *his* particular route, until, for sheer relief from the intricate confusion into which our investigations served only to plunge us, we frantically chose a route at last, caring but little where, save that it led towards the valley and *from* our besiegers. The route we selected is that known as the Hutchings route, so named, I supposed, out of deference to the estimable gentleman whose name stands so intimately connected with the history of the Yosemite. The route is *via* railroad from San Francisco to Stockton and Milton, a distance of about 100 miles; thence by stage

to the Calaveras grove of big trees, and hence by the Coulterville trail into the valley. We had not been many hours on the road before we came to the conclusion, in common, doubtless, with all tourists, that we unluckily had selected a route embracing the rockiest roads, the deepest and vilest dust, the steepest grades, and the most reckless, unmerciful Jehu on the whole coast as our driver. But learning shortly that these were but the necessary evils common to California staging, in whatever locality, we modified our views, and now believe that this route, though blindly chosen, is the most desirable one into the valley, inasmuch as by it the equipments are fully equal to any other, and it possesses the advantage of passing through, or rather over, several mountain ranges the beauty of whose scenery alone is well worth the fatigues of the trip. The familiar "all aboard!" at the Central Pacific Depot was to us an equivalent for the whole phrase "To the big trees and Yosemite." In a few hours we find ourselves at Stockton, where we change for the cars of the Stockton and Copperopolis Railroad, a new road at present completed only as far as Milton, but designed to penetrate further eastward into the foot hills of the Sierras, which for the tourist will

be eminently desirable, as it will lessen by over 100 miles the staging now necessary to reach the valley, which is by far the most trying experience of the traveler to that region. The course of the road from Stockton is across the rich level valley of San Joaquin, which for the distance of twenty miles presents one unvarying scene of richest productiveness and fertility; after which by insensible degrees it becomes more rolling and broken, until it at last merges into and forms what are called the foot hills of the Sierra Nevada mountains, strictly the transitional link between the mountain elevations above and bordering valleys below. When about two-thirds of the distance from Stockton to Milton, I first beheld, projected against the blue sky far in the distance, the faint profile of the Sierras, that wondrous range in whose hidden recesses are contained so many objects of grandeur and sublimity, the works of Nature in long past and unrecorded ages.

On arriving at Milton our baggage and other accoutrements were speedily transferred to the ponderous Concord coach, which is ever in readiness at the station for its victims. On presenting our credentials we were at once assigned the choicest seat by the busy and accommodating manager of

the line. Now it must be borne in mind that while the adjective "choice" applies rather ludicrously to anything pertaining to a western stage, yet there are a few seats that possess a preference over others; not, however, for the comfort they yield that the others do not, but the tortures inflicted are milder in degree, and more within the bounds of human endurance—a merit rather of a negative than a positive nature. This seat is on the top of the stage and adjoining the driver, who, as a general thing, is of a jovial nature, with a vast fund of anecdote and humor, which serve much to enliven what otherwise would soon become a tedious, monotonous journey. Having thus satisfactorily embarked, we soon were on our way over dusty plains, through rocky gulches and ravines, and Milton, with its scattering houses and dismal, dusty streets, was soon hidden from view.

On our slow, toilsome way up the ever increasing rugged mountain slope, we found abundant leisure to indulge in dreamy speculations as to the far-off geologic history of this land. The whole face of the country bears a written record of the great changes wrought by the mighty elements in primeval ages, and we can trace with ease the last finishing touches of the final subsidence of oceanic

waters, which moulded and carved this vast extent of surface into a thousand varied forms and shapes of beauty, grandeur and sublimity. High up toward the summit can be seen the denuded peaks of primitive rocks, still the same as when ceased the strife of the battling elements, plainly bearing the marks of the fiercely lashing waves; and as we descend we find rows and piles of broken granite, ground and worn by the action of the water, decreasing in size and number, here and there an ever increasing quantity of finely comminuted rock, mixed with a growing proportion of argillaceous matter, cementing into hillocks and ridges until, reaching the valleys below, the subsiding waters at last deposit there the rich alluvium gathered from the inhospitable regions above, as if by a provident economy, for the future use of man, ere they take their final departure through the Golden Gate, to find their last resting-place in the broad bosom of the placid Pacific.

Before reaching the foot hills proper, the whole country becomes one succession of verdureless, gravelly knolls of varying sizes, which, while being too poor to give life and growth upon their surface, yet prove that nothing is created in vain by affording beneath their surface homes for multi-

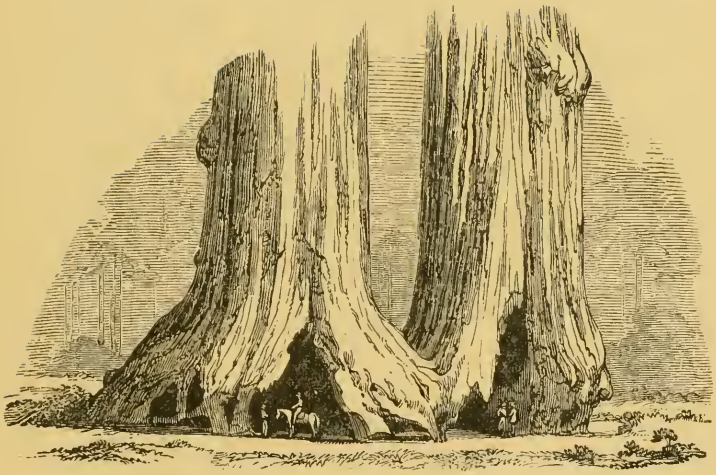
tudes of burrowing squirrels much resembling the grey squirrel of the east both in color, size and general appearance. Almost every hillside is literally honeycombed by the burrows of this active little rodent.

They are by no means alone in their habitations. They seem to have that same communal instinct which in Nebraska and other eastern sections guides them to form a social compact, a kind of co-operative society, on the very human basis of mutual protection. Here in California can be found that strange triple combination of bird, reptile and quadruped, except that the squirrel has here been substituted for the prairie dog of the eastern plain. It is a curious spectacle which is thus presented, of creatures so different in their habits and natures as owls, squirrels and snakes associating so peaceably together; but I suppose each finds in the other some compensating quality which contributes to the welfare and safety of all collectively, and judging from the perfect quiet of their homes, they form after all, perhaps, a very happy family.

CHAPTER V.

The Calaveras and Mariposa Groves.

From Milton to the Calaveras grove it is one continual ascent (since the grove is at an altitude of some 4,300 feet above the sea) varied with occasional descents of sometimes considerable distance, which are the abhorrence of the traveler, for well he knows that every foot he descends must sooner or later, by slow, toilsome steps, be remounted. The route for the first forty miles is of the most sterile character one can conceive; no growth of vegetation except occasional clumps of Manzaneta and scattering clusters of sage brush, to which the dry, barren soil yields an uncertain support, and which are found sustaining a feeble existence only in the more favored spots. So complete and universal is the paucity of moisture and verdure that one would naturally conclude that nature had defrauded this section of the necessary substance out of which the Yosemite and big trees



THE SENTINELS.

were produced. After four or five hours of wearisome ascent which, reduced to terms of distance, means ten or twelve miles, we alighted, much fatigued and very hungry, to begin hotel life in the rural districts of this country. We ate a very passable dinner served at a rude hotel near by, but cannot now remember whether we enjoyed the rest or the eating most. At this place we made our first change of horses, which henceforth is regularly made at about the same interval. A truly humane provision is that of these frequent changes, as toiling up a steep grade dragging a heavy coach, well loaded, over the roughest roads in the world and in a choking dust, is a trying thing for the poor brutes.

Continuing over much the same country, we arrive late in the afternoon at the lively little town of Murphy's. How queer it is that in a land where such outlandish names as Poker Flat, Yuba Dam, Red Dog Gulch, &c., &c., are so common, we should find a town with the simple, homely name of Murphy's! Yet Murphy's it was, and we shall ever remember it gratefully for a most bounteous supper, and its delicious wines, of which we partook while our driver busied himself in completely transforming our whole outfit, preparatory to a yet

more steep and rugged ascent than we had hitherto experienced. It is from this point that the real ascent begins; for although we are now within only ten miles of the Big Tree grove, we have in that distance to mount to the height of over twenty-three hundred feet. So it becomes necessary that all superfluous weight be discarded. We therefore change the heavy, lumbering coach for that peculiar contrivance, the California stage, which possesses all of the bad qualities of the other and none of the good.

Our route now lies along the steep declivity of a canyon through whose rocky walls rushes and plunges in a thousand cataracts the waters of the Union Ditch Company, which is obtained by diverting the head-waters of the Stanislaus river, a hundred miles above, and carried in ditches, pipes, raceways and flumes around, over and through the rocks and gulches of the mountains, and at last discharged into this canyon to be carried down into the foot hills and valleys below, where it is used for mining and irrigating purposes. We had scarcely begun the ascent of this canyon ere we noticed a marked change in the surrounding vegetation, which became more and more abundant, larger of growth, and of greater variety as we advanced, un-

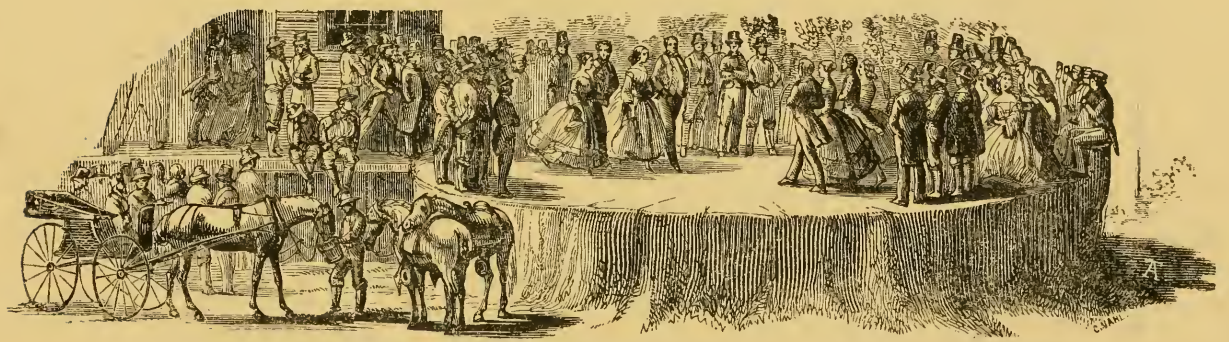
BIG TREES OF CALAVERAS.

til we were at last encompassed by a forest of such marvelous growth as to strangely contrast with the absolute want of timber further down. I learn that it is a characteristic of this section that the nearer you approach to the summit of the Sierras to within a defined limit, the larger becomes the growth of timber. There seems to be a zone along the western slope within which all the favorable conditions of soil, temperature, moisture, &c., contribute to excessive vegetable production. I am sure, were I to truly describe the number and sizes of the different varieties of trees that I saw in the course of an ascent of this range, I should be charged with exaggeration. The timber is mainly yellow pine, although fir, balsam and cedar are thickly scattered throughout, and of unusual growth. It is no unusual circumstance to see pines six to eight feet in diameter, and from 150 to 250 feet high, clustered in groups or distributed irregularly in dense groves over the slopes or in deep defiles. So gradual and constant is the increase in the size of the timber as you ascend, that the mind becomes prepared in a measure for the miraculous growth of the big tree grove, and the effect upon the traveler of this giant forest is much lessened by the gradual increase in magnitude

to which the eye has thus become familiar.

Just as the last rays of the sun gilded the distant mountain tops, we entered the great grove of Calaveras. The entrance into the grove is a befitting one, the road passing between two of the largest trees, called "The Sentinels," each being nearly 26 feet in diameter and over 300 feet in hight.

So familiar had I become with the illusions of magnitude and distance in this country that I had somewhat prepared my mind for that feeling of disappointment so universally felt by travelers when they first see these trees; so if I did not share in that prevalent feeling it may be due to the fact that I had studied the causes and was prepared for the effect. So symmetrical are these huge trees in their proportions, so gentle and regular their taper upwards, that one fails to be impressed with a sense of their real magnitude, yet by continued observation and a growing familiarity their true size is gradually realized. While at first they do not impress us with their unusual size, yet the singular want of correct proportions in other and adjacent familiar objects is apparent, so that the real effect of these trees might be said not so much to cause an appreciation of their ac-

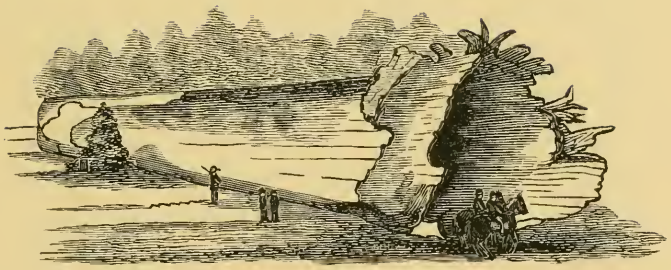


A DANCING PARTY ON THE STUMP OF A MAMMOTH TREE.

tual magnitude as to diminish in size objects of ordinary proportions around. It is a strange sight and awakens peculiar feelings. Horses, men and other objects appear singularly small when in close proximity to these trees. The horses attached to our coach, which before appeared of good size, suddenly dwindled to mere ponies in the presence of these mammoths, and I looked with bewildered senses upon the altered proportions of my comrades as they walked around their ample base. This grove is not, as is popularly believed, composed exclusively of these trees crowded together in a small compass; they are, on the contrary, scattered over an extent of some eighty acres, and rarely are more than three of them found near each other. They are distributed irregularly through a dense forest of pines and cedars which are themselves of a size to excite the profoundest wonder in any other section. Another singular fact connected with this species is that no trees of this kind small in size are to be found, and nowhere do they occur except in limited areas, comprising perhaps not more than a dozen localities throughout California. They are not to be met with except where integrated into these well defined groups. There are ninety trees of this variety

in this grove (the Calaveras) ranging from fifteen to twenty-six feet in diameter. Among the larger we may mention one that required the labor of five men twenty-two days in felling it, which was accomplished by boring it off with pump augers. So large an area of support did its ample diameter afford that after it was completely separated it required the aid of wedges to throw it over. Five feet above the ground it was twenty-five feet in diameter without the bark and twenty-eight including it; for it must be remembered that the bark of these trees varies from twelve to twenty inches in thickness. The stump of this tree has been carefully leveled, and upon it a cotillion party of four sets have danced at one time, affording besides sufficient space for a number of spectators. This tree was over three hundred feet in hight.

The largest tree in the forest now standing is called the "Mother of the Forest," and is three hundred and twenty-one feet in hight, eighty-four feet in circumference without the bark (the bark, to the hight of over one hundred feet having been removed for exhibition) and at the hight of one hundred and forty feet is twelve feet in diameter. It is without branches to nearly the hight of one



THE FALLEN MONARCH.

hundred and fifty feet. It is estimated that this tree alone would produce nearly *six hundred thousand feet* of lumber. Think of a single tree large enough to build almost an entire village—certainly quite enough for some nascent city of the plain.

Near by lies the huge form of the "Father of the Forest," or "Fallen Monarch," said to be the largest tree in the grove, partially buried in the earth and far advanced toward its final decay. It measures 110 feet in circumference near the roots, and is estimated to have been 430 feet in hight, as at a point three hundred feet from its base it is eighteen feet in diameter. The remaining upper portion having decayed, its total hight becomes a matter of comparative computation. For two hundred feet of its length it is hollow and of sufficient size in the interior to permit a person to walk erect. This tree would have yielded, according to a very moderate estimate, over *one million and a half feet* of lumber!

The "burnt tree" is also prostrate, and has been hollowed out by frequent burning until a horseman can ride into it a distance of over sixty feet, a good liberal thickness of wood remaining as a shell. This tree when standing was three hundred and thirty feet high and ninety-seven feet in cir-

cumference. A large number of these trees show visible signs of decay, whether from ripe old age or from the frequent fires that abound in these regions is not known; but at the present rapid rate of destruction of these grand old relics of past ages, a few more centuries may see them numbered with the extinct giants of other of nature's productions. This species belongs to what scientific men call "Sequoia Gigantea," and bears a very close external resemblance to the common cedar, the wood, however, being of a lighter and more porous nature, and of but little value in the arts.

Southward from this grove some six or eight miles is a still more wonderful collection of these trees, known as the South Grove of Calaveras, and no doubt by far the most extensive yet found in California. In this group there are over 1,300 trees, all of the most astounding proportions. One of the largest, now lying prostrate, is of such immense size that a well-loaded Concord coach could be driven for a distance of two hundred feet through its trunk. A majority of these fallen trees, in common with the one mentioned, are hollow, forming immense tubes.

Attractive as are these monsters of the vegeta-

DESCENT INTO THE VALLEY.

ble world, we become weary in the vain effort to render in consciousness a clear conception of their vast proportions; and with continual visions of the Yosemite haunting us, we are anxious to be off for the valley. So at early dawn we bid adieu to the big grove and resume our journey thither.

CHAPTER VI.

En Route for the Valley.

If the reader will examine a map of California, it will be observed that along the entire western slope of the Sierras there are parallel valleys coursing westward and at very short distances apart, so that a cross section of this range midway from the summit to the valley would present a serrated edge not unlike a saw—to which fancied resemblance the name Sierras is due. The reader will now see that our route to the Yosemite lies over two of these valleys and dividing mountain ridges —the Table Mountain and Tuolumne. After leaving the grove by a rapid descent—in which the daring soul of our reckless Jehu found delight in the cheerful effort to dislocate our joints or break our limbs, and involve us in as much peril as possible by furious driving down steep rocky grades and sharp curves, all the while heedless of our appeals for caution and moderation—we arrived at Mur-

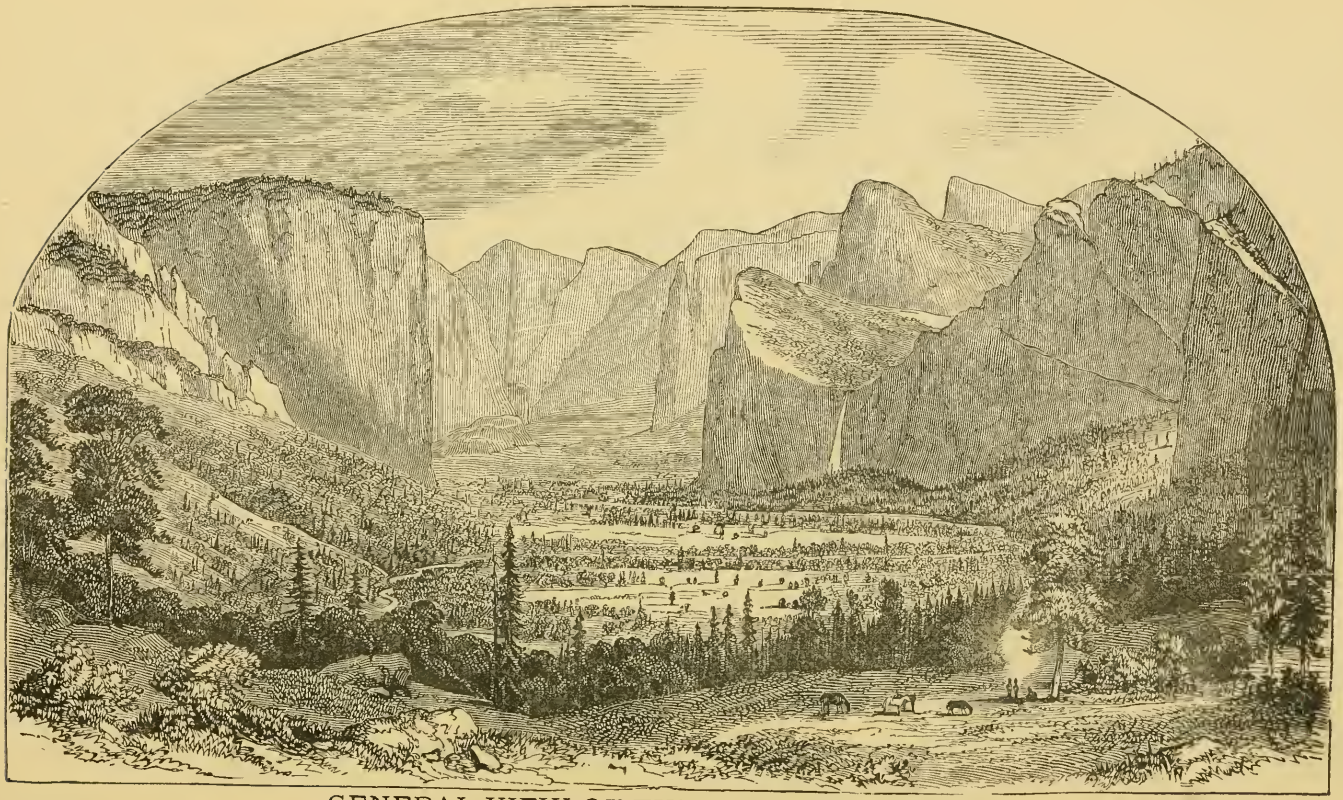
INDIAN TRAIL UP THE MOUNTAIN.

phy's prepared by a most unmercifnl thumping to refresh ourselves by a bounteous breakfast and a liberal consumption of the enticing wines there to be found. This done, we again set out for Volliceto, four miles distant, a quaint, dilapidated, Spanish-looking old town, whose long, narrow streets and ragged houses showed that whatever once might have given vitality to the place had long since departed. We here again change stages. Whatever of monotony there may be in California staging, it cannot be because this eternal changing does not give it variety. So chronic, in fact, has this feature of the journey become, that at the sight of almost every old tumble-down shanty I involuntarily seized my valise, preparatory to that inevitable change which I believe must certainly follow; and I may truly say that I was seldom disappointed.

Bearing our course through a country the scenery of which was one ever changing panorama of beauty, a sudden sweep around the summit of the mountain brought to view a spectacle of unrivaled grandeur. Far in the distance below rushed the sparkling waters of the Stanislaus (pronounced *Stan-is-low*) which seemed but a bright silvery thread, a mere rivulet, from our dizzy hight above,

stealing softly through the winding mountain passes. But after a long and swift descent, we found a river over whose turbulent waters it required the aid of a ferry to safely pass. This we did near that classic ground where occurred the sanguinary "warfare with the remnants of a Paleozoic age" so graphically described by Bret Harte in his "Row upon the Stanislaus." The scenery at the crossing of this river and in the subsequent ascent on the other side is by far the finest we have met with thus far on our route. But we cannot tarry to indulge in a description of its loveliness, the interest of which is much increased by the fact that in this section for many years was the home of Mark Twain and Bret Harte, whose memory is still cherished by the inhabitants, as almost every one can give you some pleasing reminiscence of those great humorists.

A laborious ascent of a few hours brought us to the summit of the dividing range between the Stanislaus and Tuolumne rivers, when by a quick drive we reached the village of Columbia. Nothing worthy of note occurred here save the one unaccountable, startling fact that we did not here change coaches. Columbia is now a ragged, lifeless town, but was once full of busy life, and in its



GENERAL VIEW OF THE YOSEMITE VALLEY.

more prosperous days contained several thousand inhabitants. It lies on the verge of the great placer mining district of California, or, more properly speaking, what once was a mining district, as now but very little except quartz mining is done in this section. The country, for miles in every direction, here presents that naked, barren condition so peculiarly the result of the hydraulic system of mining. All the solvent particles of the soil, together with those of a loose movable nature, have not only been washed from their bed, but carried away into the capacious gulches and ravines, miles distant, leaving the country in an inconceivable state of nakedness—a sight sorrowful to behold. Rising on every side can be seen the pale glinting peaks of jagged rocks, that rear their heads again after being for ages entombed, and now rest on the mountain slopes as one vast Mer de Glace, or like the billowed fields of ice in a northern sea. As the hydraulic method of mining has done so much to change the surface of California, a more detailed description of the same may not be without interest. High up towards the summit of the Sierra Nevadas the engineer selects a favorable point where a portion of the headwaters of some river can be diverted from its channel. It is then car-

ried in a canal or ditch, usually of the size of an ordinary mill-race, conveyed in this manner perhaps for a few miles, winding around mountain summits and curving around the head of some gulch or canyon, then for miles it may be carried in wooden flumes, supported by lofty trestle work high above the valley whose intervening space it becomes necessary to leap. When thus transferred to the opposite side of the valley, ditches, flumes and pipes are again used in frequent succession, until the water is at last conveyed into or near the mining district where it is to be used.

The difficulties encountered in the construction of these works are often very great, and their successful completion requires the outlay of large sums of money. It is no uncommon thing to carry the water in the manner described for nearly one hundred miles before one drop of it is used for the purpose ultimately intended. Some special feats of engineering connected with these works deserve particular mention. In the construction of the works of the "Union Water Company" it became necessary to carry the water along the face of a perpendicular wall of rock several miles in length and several hundred feet in hight. This was done by suspending a wooden flume miles in length and

EL CAPITAN—3,300 FEET HIGH.

about midway down the rocky buttress, by iron rods secured to the verge of the cliff above. In order to prepare the fastenings for these bolts, workmen were suspended by ropes from above, who wrought in the perpendicular face of the rock the necessary anchorage of the supporting bolts. Over an impassable gorge I noticed that the water was sometimes carried in iron pipes, which in turn were supported by a suspension bridge of construction similar to larger structures of the same kind. In crossing a valley in the Tuolumne range, I noticed where the water was carried in an iron pipe at least two miles in length and following the depressions of the valley. This pipe was eighteen inches in diameter, and at the lowest point could have been but little less than four hundred feet below the surface of the water in the canal above with which it connected. I was much astonished at first to observe that the thickness of this pipe only slightly exceeded one-eighth of an inch, knowing that the pressure under this great hight was but little inferior to the tensile strength of the iron. But on reflection I soon saw that a very small excess of strength in the pipe was necessary, as having free communication at either end with the canal, no sudden check in the flow of the water could en-

sue, and the pipe, therefore, was not liable to undue and excessive pressure from that cause. I am sure that the company referred to have not less than twenty miles of wooden flume. After the water has thus been carried into the vicinity of a mining district, the main canal is divided into a great number of smaller ditches, each taking a different direction into the various sections of the mining locality. This forms the primary system of distribution. It is afterwards again divided and subdivided into small sluices and ditches to meet the wants of individual miners, so that the entire mining district is completely ramified by an intricate net-work of small channels, sluices and pipes. After the water has been used it is again collected, far down some valley, and again made useful to the miner by a similar re-distribution; so that it is no uncommon thing for water to be utilized in this manner many times over.

It is astonishing to see with what avidity the miner has sought every portion of earth he may chance to believe would pay for the labor of working. Even the streets of this town have been furrowed and undermined in search of the precious metal; and I noticed that houses had been removed for the same purpose. Even the sacred

BRIDAL VEIL FALL—940 FEET HIGH.

precincts of the dead scarcely served to stay the searching greed of the miner, and his eager desire to explore the tempting "pay dirt" that held the remains of the rude forefathers of the placer impelled him to carry his denuding efforts to the very verge of the church-yard; so that it stands a solitary promontory in this vast scene of desolation, at once the tomb of the lifeless miner and a fitting monument to the living miner's absorbing thirst for gold.

As placer mining has now to be numbered virtually among the extinct industries of this country, these grand monuments of the enterprise and skill of the early settlers are now no longer used, save in a limited way, for their original purpose. But upon the ruins of one industry has arisen another, and happily these artificial water-courses are yet preserved, in the main intact, for the purpose of irrigation, thus giving rise to a far more enduring and lucrative industry.

Leaving these desolate fields, a few hours' travel changes the scene into a most cheerful and inviting one. As we approach the beautiful town of Sonora the aspect of the whole country reminds one of Italian softness and sublimity. Here are to be found the finest orchards in the State, and

the astonishing fruit-producing resources of California become apparent. The eye is greeted by an endless succession of orchards, whose unrivaled abundance and quality of fruits is equaled only by their variety. Within the limits of a single garden I observed, growing in rare perfection, apples, pears, peaches, apricots, plums, figs, grapes, nectarines, oranges and lemons—a promiscuous collection which I believe impossible to any but the genial clime of California. At Sonora occurs another change of coach, and after tarrying for dinner we set out for Chinese Camp, which we reach after the severest experience of heat and dust we have yet encountered. Chinese Camp is not, as the name would indicate, of Chinese population, but acquired the name from the fact of a few Chinamen settling here at an early day, an event deemed of sufficient importance to be commemorated in thus naming the town.

Soon after leaving Chinese Camp we reach the Tuolumne river, along whose banks our route now lies, passing occasionally small, antiquated mining camps, some orchards, and now and then a ranche of some pretensions; and at last cross the river in one of the rudest imaginable ferries, but in a most romantic spot. We now follow in the rocky bed

NEVADA FALL—740 FEET HIGH.

(now dry) of a tributary of this river, until we reach the foot of the Tuolumne range of mountains, which, by an ascent of tedious slowness, we climb for hours. The tax on our patience is in a measure compensated by the grandeur of the scenery which gradually unfolds in a thousand varied forms of beauty as we mount toward the summit.

Garrote (a rather ominous name) is our next stopping place, which we reach at a late hour of the night, very tired and hungry, glad to avail ourselves of the few short hours for sleep given the traveler; but scarcely shut our eyes until we are ruthlessly aroused, to resume our journey at a very early hour. Garrote, until within a year and a half, was the nearest point to the valley which could be reached by stage; so from this point the tourist took the saddle train and rode into the valley, a distance of about forty miles. The rapidly increasing desire to visit the Yosemite has caused the construction of a very passable road to Tamarack Flat, a distance of about thirty miles from this point, and perhaps as far towards the valley as it will ever be practicable to construct a road; as I doubt if the engineering skill of this or any other age will be equal to the task of constructing a road from the last-mentioned point into the valley.

On the road from Garrote to Tamarack Flat we again meet with that gradual increase of timber to be observed in the ascent of almost any of the parallel ranges on the western slope. When at a distance of about six miles from Tamarack Flat we pass through the Tuolumne grove of big trees of the same variety as the Calaveras grove. There are in this grove some fifty of these trees, many of which are very near the road, so that from the coach one gets a very satisfactory view of them. What I saw in this grove I have not the space to detail, but suffice it to say, it contains specimens of these trees that will entirely satisfy those who do not wish to make a detour to the Calaveras grove, the trees of which surpass those of the Tuolumne grove only in number.

YOSEMITE FALL—2,634 FEET HIGH.

CHAPTER VII.

In The Valley.

At Tamarack Flat we find the saddle train in readiness for us, and are soon prepared to descend into the valley, which is ten miles distant and nearly five thousand feet below this point. While equipping ourselves for this new experience, we learned from our guides a rather amusing incident which occurred on the occasion of a recent visit of Susan B. Anthony to the valley, and which the guides took great delight in relating to all travelers. It seems that the worthy lady, on arriving at this point, was seized with a laudable desire to give some tangible proof of the fitness of her claims to be called strong-minded, and resolved to ride into the valley on that modification of a saddle which the usages of all nations have decreed to the sterner sex. But this design was more readily conceived than executed; as after she had vainly

tried to adjust her person to some ten or a dozen saddles, various in their construction, she only at last so indifferently succeeded that after a trial of a few miles she abandoned the effort altogether—thus indicating a degree of femininity that must have been discouraging in the extreme to one whose chief ambition is to prove the umlimited masculine capabilities of her sex.

We have now to make a descent of almost 5,000 feet in order to reach the valley, which is itself 4,000 feet above the sea. The distance into the valley is about ten miles, counting the sinuosities of the trail, but perhaps not half so far in a direct line. After a steep descent of an hour or more through a dense undergrowth of brushwood, quite shutting out all distant views, our guide suddenly dismounted and secured his beast to a convenient bush, we following his example. Here the unsuspecting traveler is cheered with the momentary hope that the end of his journey is nigh at hand; but, as I was soon to learn, the real problem of descent into the valley remained to be solved. Following our guide a short distance, we suddenly emerged from the brushwood upon a bold projecting rock, known as Prospect Point. The scene of unrivaled grandeur thus suddenly disclosed can

never be described. Never shall I forget the feelings of mingled awe and wonder awakened by this scene, and to the latest hour of my life will remain impressed upon my memory a vivid picture of the ineffable glories I there beheld.

There are scenes of distance and magnitude that outrun the powers of thought; so there are spectacles of bewildering beauty and sublimity that transcend imagination. I could only gaze in silence upon the awe-inspiring grandeur of the vast and solemn immensity stretching out before but far beneath us. Three thousand feet below rushed the silvery waters of the Merced (River of Mercy) whose thunders are lost in a thousand ever weakening echoes among the stony battlements that imprison it, so that a profound stillness reigns, as if to deepen the impressiveness of the scene. When we say 3,000 feet, few can realize so great a hight. Let us aid the imagination. Many of my readers, doubtless, have gazed down upon the seething waters of Niagara from Table Rock. If an elevation twelve times as great can be imagined, some idea of the hight of which I speak may be realized.

With no small effort we turn from this entrancing scene to resume our descent.

The guide now carefully examines our saddles to reassure himself of their security—a precaution well taken, as we soon see, for with all our experience with steep grades we have encountered none like these which are before us. The trail which we follow is narrow, crooked and in many places treacherous; and is, in fact, merely a small groove made by separating the mass of broken granite and gravel that lies on the steep declivity, and which by long and continual use has been worn to a considerable depth. About half way down, the trail makes a sharp turn around a projecting point and passes but a few feet from the verge of a fearful precipice, so near that one fatal misstep of the sure-footed beast would have plunged rider and all in one frightful descent into an abyss of over one thousand feet, without so much as a twig to stay their fall. We finally reach the Merced river, along the banks of which we follow for a mile or more and then enter the valley. We at once seek the hotel, which is kept by that very pleasant gentleman, Mr. Hutchings* (to whom the world is mainly indebted for a knowledge of the Yosemite) who is

*Mr. Hutchings is the author of a very interesting and popular book entitled "Scenes of Wonder and Curiosity in California," published by A. Roman & Co., 417 and 419 Montgomery Street, San Francisco, and 27 Howard Street, New York City.

unsparing in his efforts to make all around him agreeable and cheerful—and seldom does one see efforts more effectual.

Since we are in the valley, let us gaze about us and study some (for the possibilities of the case limit us to only a few) of the endless wonders that encompass us. The valley is elliptical in form, about six miles in length and nearly 1½ miles at its greatest width, diminishing both to the North and South to a mere narrow pass between the rocky walls, through which the Merced river enters and emerges, winding irregularly through the valley near its center. The soil of the valley is for the most part quite fertile, as a prolific vegetation shows. There are several very promising orchards here, and many beautiful gardens.

The geologic formation of this valley is a first-class problem for scientists. Unlike the many parallel water-courses that find their way down the western slope of the Sierras, the Merced does not descend in conformity with the general slope of the country, but here, for the distance of some six miles, suddenly drops several thousand feet, afterward descending in a gradual, uniform manner, as in common with the other rivers of this country. Scientific men have assigned the origin of this val-

ley to several different causes. Some maintain that it is a fissure produced by the bending of the primeval bed of rock. Others attribute it to that common origin of valleys, erosion, while others insist that it has been caused by subsidence or a sudden sinking away of so much of the country as now constitutes the area of the valley—literally, to use an expression current there, that the bottom has fallen out. To myself the first seems the most satisfactory explanation, yet there appears to be wanting as essential to that theory that conformity of the opposing walls of rock which ought to be found under the hypothesis. Yet this, after all, cannot be held to seriously militate against the theory, since it is to be noticed that the granite composing these cliffs is unusually soft and hence liable to rapid destruction; so that the work of the elements through long ages might have entirely changed the original contour of these rocky walls.

Taking our position in the center of the valley, we see perpendicular walls of rock in every direction, rising to the hight of three or four thousand feet above the valley, so that a sense of isolation and imprisonment thrills one with a momentary terror. Nothing in all nature can equal the scene now about us. Europe has its Gibraltar and Lau-

terbrunnen: Asia its stony battlements of the Daghestan; Africa its roaring torrents of the Zambesi and the mysteries of the Nile; South America its frowning Chimborazo—but what are all these to compare with the overshadowing splendor of El Capitan and Cathedral Dome, the Yosemite Falls and Pohono's ever wind-obeying veil, the glittering torrents of Nevada and Vernal Falls, the Cap of Liberty, Royal Arch and a thousand other objects of equal grandeur and sublimity crowded here into one majestic presence within the momentary gaze of the beholder!

To the left, more than a mile away, rises the gray frowning front of El Capitan, over 3,200 feet perpendicular; a hight so great that our efforts to realize it will be aided by the fact that although more than a mile distant, in looking towards its summit it subtends much the same angle as would a tall steeple viewed from across a street. On the opposite side, standing as lofty watch towers, rise the Cathedral Rocks to a hight of over three thousand feet, over which pour the waters of the Bridal Veil Fall, in one long unbroken sheet of watery foam of dazzling brightness, 940 feet in height. Nothing can exceed the beauty of these falls, viewed at a distance. The water does not seem to

fall through this great hight, but merely floats or drags its course along, down the wall of rock upon which it seems to rest. Directly in front of you, in full view, are the highest waterfalls on the globe —the Yosemite Falls, which, including two small breaks, descend through a hight of over 2,600 feet. The first of the series has a clear descent of 1,600 feet. Think of one unbroken fall nearly eleven times as high as Niagara, or nearly nineteen times as high, including the whole fall!

Like all objects of unusual extent and magnitude, this valley produces in the mind of the beholder such singular impressions and indefinable ideas that it is useless to attempt to convey to others by mere description an image of it. I can only say that it is one of those things that must be seen ere a correct impression of it can be obtained. I have seen many of the finest paintings of these falls, besides many splendid photos, neither of which, certainly, can be charged with a departure from reality; yet none of them have, nor as I believe can have, the power to represent their subject in all its grandeur and immensity. Trees that rear their lofty tops hundreds of feet in the air seem but little shrubs growing at the summit and base of the falls. I noticed one which I was told

is 125 feet high; yet I had to multiply its hight nearly thirteen times upon that rocky wall, against the foot of which it stood projected as a mere shrub.

The limits of our time forbid other than a mere glance at the Nevada Fall, where the entire waters of the Merced plunge 740 feet; the Cap of Liberty, a cone-like rock rising alone over three thousand feet; the Vernal Fall with its world of beauties; the Royal Arch, or the vast Domes, most perilous of ascent, rearing their solemn heads over four thousand feet above the valley. Weeks, nay months might here be consumed ere a satisfactory view could be obtained of the endless panorama of wonders which nature here spreads before us.

But the mind wearies in the vain effort to take in magnitudes so vast. Let us then turn to scenes more, as we may say, of this world. Following up the main valley for a mile or so and leading off to the left up a narrow defile, being the course of a branch of the Merced, with which it here unites, we find about one mile from the mouth of the canyon, Mirror Lake, which to many is an object of unusual beauty and mystery. It is a lake of about two acres in extent, from the silvery surface of which surrounding objects are reflected with surprising accuracy and distinctness. The bold

rocky peaks which quite surround it are at certain hours of the day reflected with almost the vividness of the object itself. Upon its waters is a rustic boat for the accommodation of those who wish to obtain varied reflections. From careful study of the lake and its surroundings I am led to assign this peculiar power of reflection to three causes: first, to the perfectly placid surface of the lake, which is owing to its complete enclosure within high rocky walls, preventing it from being ruffled by even a breath of air; second, to the great transparency of its waters; and third and mainly, to a deposit of iron that is held by the waters in mild solution. This I noticed was evenly and uniformly deposited over the whole bottom, giving it quite a dark color, the effect of which is similar to that obtained by the well-known practice of smoking or covering with any dark substance the obverse side of a glass to highten the reflective power of its surface next the eye. These combined causes I think amply account for the strange phenomenon, without our being compelled to refer it, as popular superstition has, to some mysterious, occult power in the water.

It is not possible in the limits of a single chapter to even mention all of the wonderful objects to be

seen in this valley; and as our time is up to return, we with many regrets leave this loveliest of spots upon this globe. Our return to San Francisco was by the same route as that already traveled, and was unattended with any important incidents. I however noticed that many objects that on our way to the valley attracted my attention by their unusual magnitude now seemed reduced to very ordinary proportions—so strangely do our ideas depend upon the relativity of things.

After five days of relentless thumping and bumping in that highest triumph of the tormentor's art, a California stage, wrapped in a stifling cloud of alkali-laden dust, broiled by the fierce glare of a tropical noon-day sun or chilled by a wintry mountain blast, mentally weary and physically prostrated, if I were asked "Does it pay to go to the Yosemite?" I should unhesitatingly reply "It does!" And let me here urgently insist, if you are in California, that you do not by any manner of means fail to visit the Yosemite—not only for the marvelous scenes there to be beheld, but to determine for yourself whether what you do see is an adequate equivalent for the days of privation and toil you endure in search of it.

CHAPTER VIII.

THE SANDWICH ISLANDS.

From San Francisco to Honolulu.

On our arrival at San Francisco we were pleased to learn that the steamer on which we were to take passage for the Sandwich Islands would be delayed a few days beyond the advertised time, in consequence of a detention of the London mails. This gave us a few days in which to stroll through the city and shake off the dust of sixty days' travel across the continent. Through the kindness of our most excellent Postmistress, Mrs. Sanderson, we were provided with letters of introduction to her nephews, Messrs. Aaron and Nathan Stein of the California Bank and Wells, Fargo & Co. To these gentlemen we are much indebted for their many acts of courtesy.

On Monday, the 27th of April, we went aboard the steamer, after having supplied ourselves with everything needful to contribute to our comfort

during the voyage, and, as I afterward learned, much that was superfluous; but being somewhat green about matters pertaining to ocean travel, in the most verdant manner possible we added at once to our stock of plunder anything our friends and acquaintances might casually suggest as of possible utility. As the through passengers from London to Aukland and Sydney rightly had the preference as to accommodations, we were obliged to wait until they were all well on board before our quarters were assigned us. We, however, managed to secure moderately comfortable quarters, myself and wife occupying the small state room given us near midship, and the Professor and an English gentleman bound for New Zealand taking an adjoining room. This line of steamers is called the Australasian and American Mail Line, and is the only one now running to the South Pacific, having supplanted the old Webb line. It carries the British mail, for which the owners receive a subsidy of £80,000 annually. The line is an experiment and is designed to compete with the old route through Suez and the Red Sea, the belief being that much shorter time can be made by this route, besides the journey being more pleasant. Our country is certainly much interested in the success of the

project, as it would cover not only the transit of immense quantities of freight through the entire length and breadth of our land, but large numbers of travelers also. The line will evidently not pay pecuniarily, from present indications, at least not directly; but true to English far-seeing foreign policy, its ultimate purpose is no doubt to form an integral part of that gigantic naval system which is fast giving to her the sovereignty of the seas. This particular line is therefore, no doubt, intended to serve as a thread to weave more securely together her South Pacific possessions, recently so largely extended by the annexation of the Fijis. The boats now running are placed on the line merely temporarily, pending the construction of five large iron steamers after the model of the White Star boats. It makes one feel small, and begets withal a sense of humiliation, that the moment one steps from the shores of the United States all traces of her greatness disappear, and even for the privilege of seeing the Sandwich Islands one has to pay tribute to a foreign flag.

Well, nothing is impossible with the omnipotent, universal Yankee; and as our country has already, in the field of art, science and literature, accomplished about all that is useful to the world, who

knows but what we may yet have a navy that will surpass the wildest dreams of a Brunel or a Scott Russell? But, after all, the present state of the case is only an equitable adjustment of values. Since we are so great, and have so much of everything else, while England is so poor in comparison, it would be the extreme of littleness to begrudge her the feeble and paltry foothold she is striving to gain in the Pacific.

Amid the usual bustle and clamor attending the departure of an ocean steamer, we drifted away from the wharf—from the city—through the Golden Gate—into the broad Pacific. Before night we had passed out of sight of land, and we were indeed in the midst of the ocean.

For the first day we felt pretty comfortable, but with occasional signs of impending trouble. There was nothing of note that occurred to vary the monotony until the second morning. As I lay in my bunk trying to make up my mind whether 'twere better to endure the ills &c., &c., I heard the Professor's English companion calling in a loud, excited manner for the steward. In answer to this call, which might have been heard in "Frisco," a waiter put in an appearance. "Tell the steward to come here! I want the steward!" was the peremp-

tory order. I began to get interested, and forgot that my stomach was clamoring for a little brandy and water. When the steward arrived, much excited over the hasty summons, the Englishman demanded of him "Do you know a centipede when you see it?" "I rather think I do," the steward replied. "Well, just raise up that pillow and tell me what that customer looks like." The steward did as directed, when sure enough, there lay coiled up in all its jointed ugliness a first-class centipede, sleeping as placidly as though he had not been all night within a few inches of a fat, juicy Englishman. This began to be rather exciting, and without proper regard to the state of my stomach or toilet, I leaped out of my bunk and for a time there was a general hunt for centipedes. In fact, I never knew centipedes in such demand. I hunted under difficulties, although, as the steamer rolled and plunged in an unusually vicious manner. I hunted diligently in every nook and corner for nearly a half hour, when at last I found—well, I did not find a centipede, but I found something a great deal worse—I found that I had to cast up accounts. This I did in a most thorough manner. There is a limit to everything, even to the contents of one's stomach; and it was only when the extremest lim-

THE PROFESSOR'S FIRST "SPECIMEN."

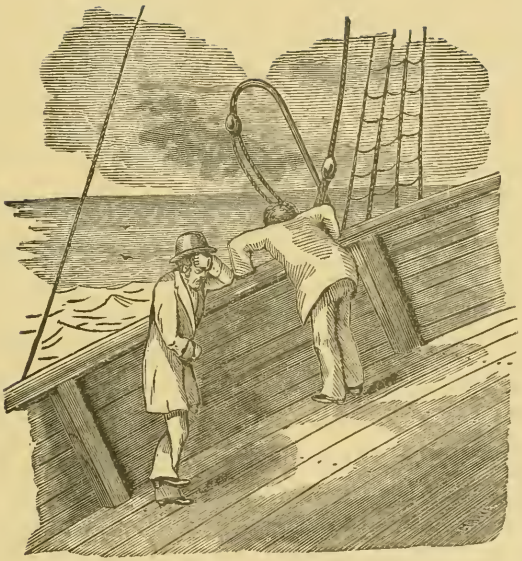
its had been reached that the insatiable demands of Neptune were satisfied. After throwing up in a lively manner for about a half hour, I forgot all about centipedes and sat down to reflect upon the situation. I had not thought the matter over more than twenty minutes until I began to suspect I was sea sick. I still think I was right. While we were all in an agitated state the Professor, true to the habit of his life, was taking a scientific view of the matter, trying to devise means to secure the centipede as a trophy. Having obtained a bottle, by dint of careful handling the ugly creature was at last stowed away in fine spirits and is in a good state of preservation.

During the day I went on deck to get a breath of bracing sea air. I found the Professor sitting in an easy chair, looking pale, weak and faint. At this juncture the Captain happened along, and with his usual civility asked the Professor how he felt. In the feeblest tones imaginable, he replied: "Miserable, miserable—I am sick, Captain, I'm sick! I have paid tribute to Neptune until I have lost everything." "But," says the Captain, "I see you still have your boots left." "Yes," says the Professor faintly, "but they were on the outside!"

Being in latitude 30°, we were nearing the region

where flying fish are to be found, and we were in hourly expectation of seeing them. Suddenly the Professor made a rush for the bulwarks, and stood gazing pensively for some time into the depths of the blue ocean. The mate, seeing him so wrapt in meditation, asked what the Professor was so intently observing. "Looking for flying fish, I suppose," I had scarcely replied, when I felt an irresistible impulse to join the Professor in his observations. After looking intently for some minutes, I saw something fly; but as fish do not fly vertically, I am sure it was not a fish. We were all quite sick for two days. It was my first experience of real sea-sickness, and I am free to say that it came up fully to its traditional horrors. After the fourth day we were all on deck again, nor were we troubled afterward save by a slight nausea at times. The Pacific ocean has the reputation of being a smooth, placid sea, but the term does not fitly apply except for a few months in the Summer. It becomes during the rest of the year, as I am informed by old salts, quite as turbulent as any other body of water.

In latitude 26° we struck the trade winds, which greatly accelerated our speed. From this onward our trip was one of unvarying monotony—the same



"NOW YOU SEE IT AND NOW YOU DON'T."

waves, the same skies and the same dull throbbing of the tireless engine day after day. Having noticed the rather mixed character of our crew, by way of pastime, I took an inventory of the various nationalities represented on board. The result was somewhat surprising even in this cosmopolitan region, where nations blend in such rare confusion. We had an English captain, Irish and Scotch first and second officers, an American purser, a Malay steward, German stewardess, Chinese cooks, Japanese waiters, Negro, Portuguese, Spanish, Kanaka, and inhabitants of the Fiji, Micronesian and New Zealand Islands for stokers and sailors. The passengers were almost as well mixed, making altogether about as checkered a crowd as you will ever see collected. We were assured by the captain that on the evening of the eighth day we would sight land; and as the time approached, as it at last did, although I thought it never would, every eye was strained in the direction in which land promised to appear. Sunset came, and no land. Darkness came, and still no land. With a feeling of disappointment most of the passengers went below. It was apparent that the Captain had missed his reckoning. About 11 o'clock the Captain called my attention to a bank of heavy clouds

just forward of the starboard bow, apparently at the distance of twenty miles. "Those clouds," said he, "are hovering over the island of Oahu, and in two hours we will be along the shore." I returned to my room and fell asleep. When I awoke it was with the sound of strange voices in my ears. I raised myself and looked through the dead-light, and the first thing that met my view was a cluster of tall cocoa-nut trees, near the shore; then a crowd of strangely dressed, dusky faced people, scurrying about in a quick, excited manner; curious one-story grass houses; a long line of whale-ships; a range of rugged, strangely colored mountains in the distance; clumps of dense, tropical verdure—an endless panorama of new and beautiful sights, bearing evidence that we were indeed in a strange land, and safe at last in the friendly harbor of Honolulu.

It was but the work of a minute to arrange our toilet, collect our personal effects and rush on deck. The view that greeted us—the broad Pacific, skirted with snowy billows as it rolled over the coral reef that incloses the harbor, the rich tropical verdure on all hands, the soft, delicious air and clear sunny sky—all combined to form a marked contrast with the wintry scenes we had so recently

left. No trick of magic ever produced an effect more thrilling or startling. As the arrival of a steamer is one of the most important events in the islands, the natives, of course, gathered in great numbers along the shore. It was to us a singular sight to see these quaint, dusky children of the sea as they surged about the wharf, a mingled mass of every age, sex, rank and condition, wildly gesticulating and chattering in an unearthly manner. The variety of costumes was something calculated to puzzle the most zealous devotee of fashion. Their garments were of every conceivable color, shape and quantity. I say quantity, because on the one hand you would see some dusky belle floating around in a bolt or two of blazing calico, formed into the voluminous "holoku," and perhaps by her side some brawny, stalwart Kanaka with rich, oily skin and hair like a hay stack, in an elaborate dress composed entirely of one quarter of a yard of dirty linen, so disposed about his person as to most nearly meet the proprieties of good society. We passed down the gangway between a long file of natives who held in their hands for sale, baskets of the most bewitching coral, and luscious fruits, such as guavas, mangos, chiramayas &c., &c. As soon as we touched the solid earth, we thought

something had happened; in fact we had a sort of suspicion that an earthquake was tilting the island about in a ridiculous manner. We expected in this volcanic region to feel earthquakes, but the unpleasant and inconvenient manner in which the earth kept swaying about was a little more of this phenomenon than we had bargained for. We began to feel a little queer, when to our inexpressible relief, I discovered that the sensation was only relative in its origin, and that it was merely an effort of nature to adjust our sea legs to the solid immovable earth upon which we again found ourselves. We went directly to the Hawaiian Hotel, a house delightfully embowered in a pleasant grove, and almost smothered under a load of clustering vines of many varieties.

CHAPTER IX.

The Topography of the Pacific.

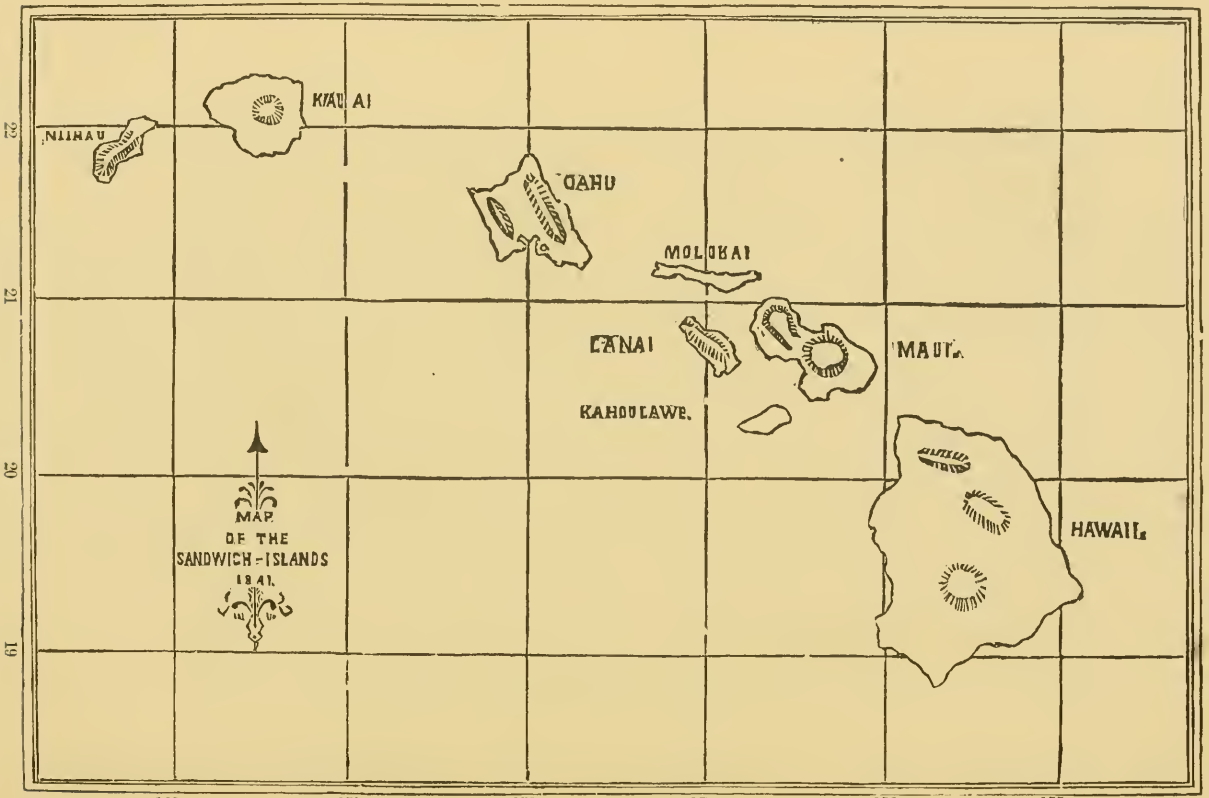
Although there exists some general popular knowledge of the islands of the Hawaiian Archipelago, I will venture, even at the risk of becoming prolix, to give a few facts touching their topography, sociology, &c.

There are in this group in all 12 islands, of which only 8 are inhabited, the rest being but barren rocks of unproductive lava small in extent. The inhabited islands are, Hawaii, Maui, Oahu, Kauai, Molokai, Lanai, Niihau and Kahoolawe, being in size and importance about in the order given. The superficial area of these islands is 6,000 square miles, Hawaii, the largest, containing 4,000, and Kahoolawe, the smallest, only 60 square miles. As they lie between the parallels of 18° 50′ and 22° 20′ north, they are fairly within the tropics. They are entirely volcanic in structure and origin; not a trace of sedimentary rock is to be found on any of the islands. The mountains are mere huge piles of

lava that has accumulated by successive overflows from the many active craters in which these islands once abounded, and which are now met with in great numbers in an extinct state.

When looking out upon the broad level expanse of the ocean, the thought is naturally suggested that the same causes which have produced as terrestrial effects, the mountain ranges, hills and valleys and other familiar conformations of surface, did not operate to vary the contour of the ocean's bed in the same manner and degree. We have therefore come into the habit of associating the level, smooth surface of the ocean with a fancied correspondence of surface below. The increasing complexity in the demands of modern navigation, arising out of the inter-relation of the rapidly growing arts and sciences, has given rise to the necessity of studying more closely, not only the complicated problems of meteorology, but the topography, the very bottom of the ocean itself.

The efforts primarily directed to promote the interests of commerce have been the means, therefore, of producing as a secondary result, a rapid advance in our knowledge of submarine geography. The long and careful study of oceanic currents, the many elaborate and exhaustive coast surveys upon

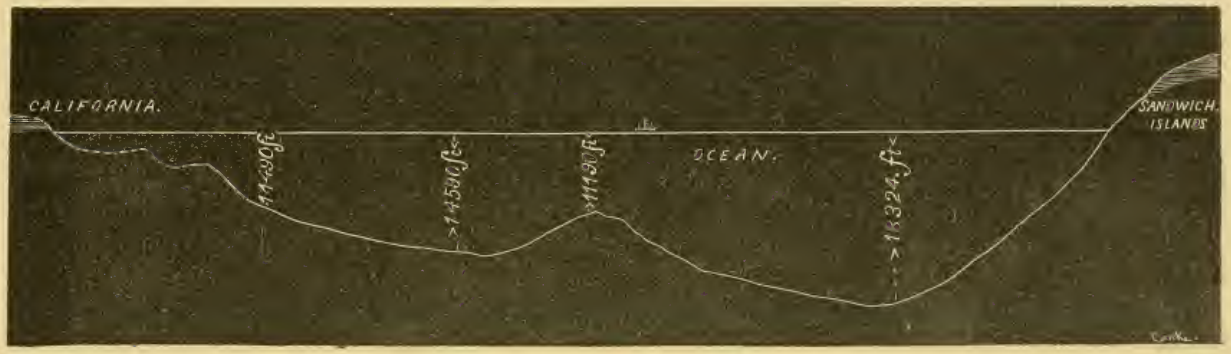


MAP OF THE SANDWICH ISLANDS.

our eastern shores, as well as the deep sea soundings necessitated by the rise of ocean telegraphy, have within the past few years familiarized us with the surface—so to speak—that lies at the bottom of the Atlantic ocean. This is especially true of that zone which lies in the international line of communication between this country and Europe, so that it may be said of so much of the topography embraced within those limits, that we are almost as familiar with it as with the topography of the State of New York or California. For various reasons, particularly the extreme difficulties in the way of effecting satisfactory soundings at extraordinary depths, our knowledge of the bottom of the Pacific Ocean has until recently been very limited and imperfect. A rapidly growing commerce with Japan, China, and other Asiatic nations, has rendered it essential that our knowledge be more general and perfect upon this subject. With a view to this end, our government, about a year ago, detailed a war vessel, the Tuscarora, for this service. This vessel, under command of Commodore Belknap, completed in a very satisfactory manner the work assigned, and the results of her soundings have only recently been given to the world.

Beginning at San Diego, California, and sailing in a direct line for the Sandwich Islands, soundings were made at intervals of forty miles, the distance being something over 2,200 miles. A line of soundings was then subsequently made, extending from Japan to the Aleutian Islands, on the west coast of Alaska. The service rendered to navigation by these researches will no doubt prove to be of immense practical as well as scientific value.

In a distance extending 100 miles west of San Diego the depth of the ocean was found to be from 3,700 to 5,730 feet. Within this distance there are two valleys, at the respective depths given, separating two ranges of peaks or mountains, the hight of the first, or that nearest the coast, being 2,670 feet, and of the second 3,396 feet. In longitude 119° 28′ west and latitude 31° 45′ north, a very sudden dropping down occurs, giving, at a distance of 115 miles from San Diego, a depth of 11,490 feet, From this point, for the space of over 900 miles. the bed of the ocean is one of almost unbroken uniformity, descending with a gentle slope of about three feet to the mile, until in longitude 127° 37′ and latitude 26° 30′, another range of mountains is found to rise to the hight of over 3,000 feet.



Bottom of the Pacific from San Diego, Cal., to the Sandwich Islands.

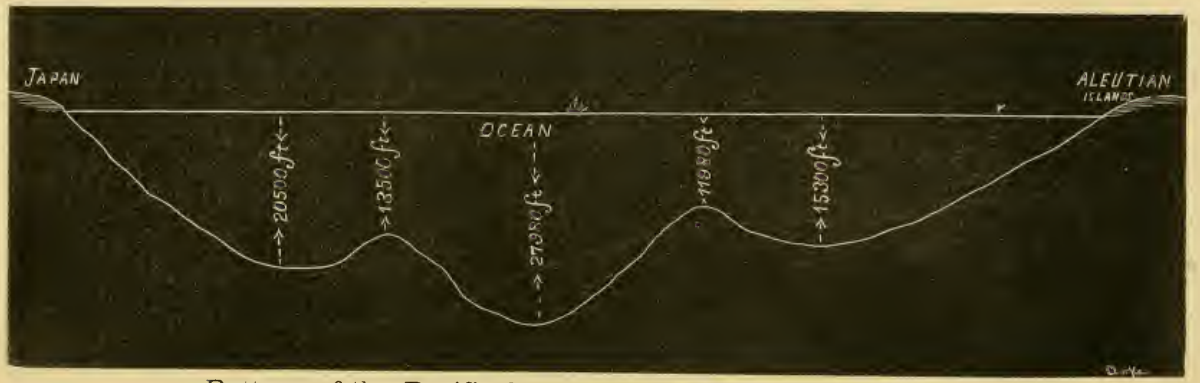
Beyond this range the same gentle declivity continues through a distance of nearly 800 miles, when a point of greatest depth is reached, at a distance of 400 miles east of Honolulu. This depth was found to be 18,324 feet. The soundings within close range of the islands gave some unlooked for and remarkable results, which lend additional strength to the theory of the almost purely volcanic origin of this group of islands. At a distance of only 24 miles from Molokai (the central island of the group) a depth of 12,516 feet was shown, and at the distance of 43 miles from the same island, the soundings indicated the great depth of 18,138 feet.

By the second line of soundings, it was discovered that from latitude 34° 58′ north and longitude 140° 15′ east, to latitude 35° 33′ and longitude 141°, with few and unimportant irregularities of surface, there was a uniform average depth of about 600 feet. Within this distance, the instrument brought to the surface fragments of shell, together with grayish black mud and sand. In longitude 141° 22′, being about eighty miles east of Yeddo, Japan, there commences a precipitous slope, quickly reaching a depth of 3,480 feet; thence by a rapid fall through a distance of nearly 120 miles, in lon-

gitude 143° 40′, the depth becomes something over 20,500 feet.

In the next eighty miles there is an elevation, in fact a mountain range 7,000 feet in hight, which is again followed by a rapid descent for the distance of nearly 500 miles, being in reality the north-eastern slope of this submarine mountain range, when in longitude 152° 16′ and latitude 44° 55′ the enormous depth of 27,980 feet, or over 5½ miles, was indicated. Here follows again a gradual ascent, being the western slope of a chain of peaks—rising by a gentle grade through a distance of 180 miles to a hight of over 16,000 feet—which is again succeeded by a depression eastward of 4,000 feet, through a distance of 300 miles, the soundings giving here a depth of 15,300 feet. This last depth is preserved with great uniformity through a distance of nearly 400 miles, when the foot of the last western slope is reached, which is in reality but a continuation of the general western slope of the American continent.

Let us examine briefly and see what are the main topographical features to be generalized out of the body of crude data here presented. By the revelations of these surveys we acquire a general knowledge of an area of the earth's surface hitherto almost



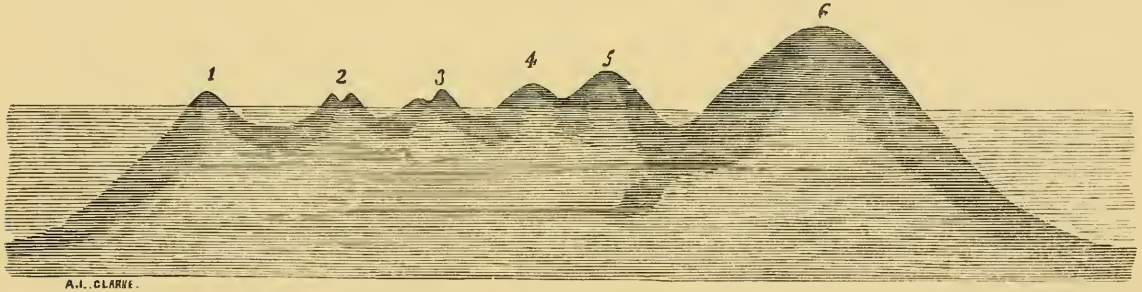
Bottom of the Pacific from Japan to the Aleutian Islands

unknown, and in extent almost equal to the entire continent of North America—that is to say, the portion that lies in the depths of ocean, and comprised within 21 degrees of latitude, and almost 100 degrees of longitude. Within this immense basin, and in the dark recesses of a watery abyss, revealed to man only through the subtle agency of a tiny cord, there are contained mountain ranges, hills and valleys, in extent, and perhaps grandeur also, fully equal to any whose towering peaks pierce the blue sky, and whose sunlit summits and gentle slopes are kindled into a thousand glories by the radiance of the heavens. By a careful examination of the data given, it will be observed that there are two great mountain chains and valleys between the American and Asiatic continents, trending, it is fair to presume, in the same general direction as those on the continents of North and South America.

It will be seen that the points of greatest and least depth, both by the Northern and Southern lines of survey, have that necessary coincidence implied by the theory of this general trend of the submarine mountain ranges. The greatest of these ranges has a hight, measured along its western slope, of over 16,000 feet—somewhat greater than

that of the Rocky or Sierra Nevada mountains. The valleys extending from the East and West bases of this range are severally over 400 and 300 miles in extent. At the distance of 300 miles to the west of the mountain range referred to, rises another to the hight of over 7,000 feet, which is in turn separated from the Asiatic continent by a valley of some hundreds of miles in width. A general profile of this region, it will be seen, would not be very unlike that given by a continuous vertical section of the Sierra Nevada and Rocky Mountain ranges, together with a portion of the eastern slope of the latter chain. We have first the valley to the east, corresponding with that of the great plains of Wyoming, Colorado, Kansas and Nebraska; and then, also the inter-mountain valley, an almost exact counterpart in extent and location of the Humboldt valley. The only points of material discrepancy are that the oceanic ranges are for the eastern chain somewhat higher than the Rocky Mountains, and for the western only about half the altitude of the Sierras.

But as we are writing specially of the Sandwich Islands, let us see what bearing this addition to our general knowledge of the topography of the Pacific has, in so far as relates to the physical



Section of Islands, Showing Elevation Above the Sea.

No. 1, Kauai, 3,000 ft. No. 2, Oahu, 3,700 ft. No. 3, Molokai, 4,000 ft. No. 4, West Maui, 7,000 ft. No. 5, East Maui, 10,200 ft. No. 6, Hawaii, 14,000 ft.

origin and characteristics of these islands. As before stated, the soundings at a distance of 43 miles from the island of Molokai give a depth of 18,138 feet. It is undoubtedly competent to assume, in view of other disclosures of this survey, that substantially the same depth exists at a like distance from the shores of the island of Hawaii, since it is only about 100 miles distant.

We think that it may be properly inferable also from the general contour of the group of islands as shown above the water line, and also from their trend as related to the slopes revealed by the survey, that this is the uniform depth along the entire eastern side of this cluster of islands. These islands are themselves, therefore, but the mere tops of some of the higher peaks of this immense chain of submarine mountains, rising, as we have seen, from a great level plain at the bottom of the ocean, and projecting to various hights above its surface. The hight to which these islands rise above the water level varies with an increasing regularity from Kauai, the northernmost of the group, to Hawaii, the most southern, the hight of the former being about 2,800, and of the latter over 14,000 feet. All grades of intermediate hight between these extremes are found to succeed in a

regular progressive order, as we advance over the group from the north to the south.

These islands are not only a part of a system of mountain ranges, submerged in the depths and immensity of the Pacific Ocean, *but they are more* —they are undoubtedly the highest range of mountains on the globe. When we speak of comparative altitudes, it is not in the geometrical sense of the respective distances of their summits from the center of the earth, but it is the hight to which they rise from the general level upon which their bases rest. The Himalaya mountains rise to the hight of 29,000 feet above sea level, but it is more than 1,000 miles from the summit of these mountains to the ocean. The Andes rise in some places 23,000 feet above ocean level; yet the summit of this range is some hundreds of miles remote from the sea. The Sierra Nevada mountains in California reach a maximum hight of 14,000 feet, and the distance from the summit to the ocean is over 200 miles; and even were we to extend the distance to more than 1,000 miles into the Pacific Ocean, scarcely 10,000 feet more would be added to their hight. As Mauna Loa, on the island of Hawaii, rises over 14,000 feet above the water level, and as the bed of the ocean, at a distance less than 50

miles from its shores, lies at a depth of 18,138 feet, we have then as a total for this mountain the enormous hight of over 32,000 feet, or a little more than six miles. When we remember that for other mountain ranges of much less altitude, the distance from the base to the summit is often over 1,000 miles, and rarely less than several hundreds, and as the distance from the base of Mauna Loa to its summit is less than 100 miles, the abrupt manner in which this volcanic cone springs from the bottom and out of the ocean becomes forcibly realized.

The facts here presented, while in themselves a source of wonder and conjecture giving scope for geographical speculations, provide also the material for geological induction.

As we are accustomed to view isolated peaks and mountain ranges, apart from any accompanying idea or conception of the earth as a whole, we marvel at the wondrous force, that invisible power that has heaved up the earth's surface in such great billows and folds, that seem to rise to such immense hights above us. But when we come to look upon them associated with the idea of their relation to the magnitude and proportions of the earth in its entirety, these geological billows and waves quickly diminish into mere ripples,—the faintest wrinkles

upon the earth's surface. By a study of the nature and formation of mountain ranges in general, were we to formulate from their varying contour and proportions some universal ratio expressing the relation of hight to basic area, necessitated by the laws and conditions out of which they have risen, we would be greatly surprised at the very exaggerated notions we often form, respecting not only the real but possible extent to which the upheaval of the earth's crust could be carried. We would learn that it is not, as we carelessly think it to be, *indefinite*, but as all things else, confined rigidly by nature's laws within fixed and determinate limits. Were such a ratio deduced, it is quite certain that it would fall short of expressing that truly phenomenal relation of hight and breadth of base, already pointed out as forming so exceptional a feature in the physical structure of the Sandwich Islands.

This ratio would most probably give for these islands a hight of little more than one third of that which we in fact find to exist. The upheaval of the earth's crust by the same and really efficient cause which has produced mountain ranges throughout the globe, would by this ideal proportion give for this oceanic range a hight of only about 13,000

feet. As no greater hight in comparison with the breadth of base can be shown to exist in any other mountain range, it is fair to presume that when the surface of the earth in the locality of these islands had reached the altitude named, it had reached the extreme limit of angular inclination which was possible to arise out of the physical conditions and causes upon which the lifting up of the earth's crust depends. Taking then the breadth of base and adopting as a standard of comparison the steepest general inclination shown by any range of mountains the upheaval of which is the direct result of plication of the earth's strata solely, the hight assumed would be rather above than below the true one. If, then, to the primary cause upon which all those undulations of surface constituting mountain ranges depends, only a little over one-third their present hight can be possibly attributed, whence must we look for that supplementary agency by which the additional hight of these mountains has been built up? We have stated that an elevation of 13,000 feet only was consistent with and possible under the conditions to which upheavals in general, covering large areas, are due. This corresponds very closely with the depth found actually to exist by the first soundings from the shore

of Molokai. A sort of terrace, beginning at a distance of 24 miles and extending some 15 miles, was found on the submerged eastern slope of this island. It seems, therefore, a reasonable hypothesis that the bottom indicated by the first sounding was the summit of the true mountain range—forced upward by the same contractile force of the earth's crust, and which is the real origin of all elevated areas—which forms a superstructure upon which, through the agency of volcanic action, the remaining and projecting portions of these islands were built up, successively increasing in hight with every overflow of molten lava, as it continued through long and countless eons of time.

CHAPTER X.

The Islands and their Inhabitants.

To those bold navigators and explorers, the Spaniards, whose thirst for wealth and adventure has given the world so many brilliant discoveries, must undoubtedly be accorded the honor of the first discovery of the Hawaiian Islands; yet it must be admitted that they stand in relation to a real, authentic discovery of these islands, much the same as the bold, hardy Northmen do to that discovery which has immortalized the humble savant and navigator of Genoa.

It is, I believe, a matter of historical record—though probably filtered to a great extent through the vague, uncertain medium of tradition that beclouds the early days and history of all countries—that about the year 1525 there were cast upon the shores of Hawaii several Spanish vessels. They are supposed to have been on a voyage from the coast of Mexico, but whether on one of those aimless, wandering voyages of a predatory nature so

characteristic of this bold, rash people, or whether they were ill-fated vessels that had lost their reckoning and drifted from the route taken by the Spanish galleons in their traffic between Mexico and the Manilla Islands which was common in the latter half of the sixteenth century, there is no means of determining. Perhaps all that can be received as trustworthy is the general fact of such a disaster having occurred near the time mentioned.

It can however be claimed as beyond doubt that in the early part of the seventeenth century, these islands were frequently sighted by Spanish traders, *en route* for the Manillas, as their charts of the Pacific Ocean of this period located with some degree of accuracy the position of these islands. Still later, in the year 1740, there was landed upon the island of Oahu a crew of white men, belonging either to the Spanish or Portuguese nations. From these men the natives procured many utensils and implements of iron, by which they acquired some familiarity with the uses of this metal. It is reasonable to infer that to this incident is due in a great measure that knowledge of iron and its uses which Capt. Cook found to exist among the natives upon his first visit to these islands.

As Capt. Cook, however, was the first to furnish

to the world an accurate, authentic account of these islands, and as his search was prosecuted in a systematic, scientific manner, it should not detract from the merit and honor of his discovery as a genuine and original one, even though it be true, as it doubtless is, that he had a prior knowledge of, and was familiar with, the rude, imperfect charts of the Spaniards, in which these islands were laid down with some degree of precision nearly a century before the date of his discovery. Who would hold the claims and honors of Columbus as less valid, even though in Icelandic annals the historian of the tenth century were to trace the adventurous Lief, son of Eric, in his uncertain wanderings to the coast of Vinland?

How these islands, isolated as they are, being nowhere within 2,000 miles of any habitable land, should have become inhabited, is a problem which has long engaged the attention of ethnologists—one which has baffled their researches, and yet remains unanswered, for want of a satisfactory solution. From the structural similarity of the many languages and dialects spoken throughout the widely diffused groups in the Pacific, differing only to that extent and degree which may be accounted for on the grounds of variation in climate, soil, and

general physical conditions, in respect of which there is among these islands a wide divergence, it is reasonable, it seems, to infer that the Hawaiians are but the offshoot of that same great division of the human family to which the Fijians, Tahitians, Samoans, New Zealanders, and the inhabitants of the South Sea groups in general, trace their origin. Whether this be the Chinese, Japanese, Malay or some other of the Continental races, matters not, as it is not their remote origin in which we are concerned, so much as the probable manner and order of their diffusion throughout the Pacific.

Although the various groups of islands in the Pacific Ocean are removed at immense distances from each other, yet it is well authenticated that in earlier times there has been intercourse to some degree among the islands. In view of the frail, unseaworthy character of the canoes in which the natives in our own times make their excursions among the islands of the various groups, together with their crude and primitive system of navigation, it seems incredible that a voyage of several thousand miles should be ventured upon by them, or should prove successful if attempted. But it is said that their boats in earlier times were of better construction, and much more suited to resist the hazards of

a long sea voyage. When we remember, also, that all these islanders are almost semi-aquatic in their nature and habits, performing feats of endurance and skill in the watery element at which a landsman would marvel, and look upon them with horror, it would seem not impossible that more by accident than design, an occasional successful voyage of this kind would be accomplished. They were no doubt—as is still the case among the more primitive and barbarous of these islands—induced to make these perilous excursions from motives of conquest and plunder, and perhaps also frequently from pangs of hunger, which even to this day gives rise to many expeditions in quest of food.

This general resemblance of the languages spoken throughout the Pacific is often remarked by the most casual observer. The Fiji Islands lie over 2,000 miles to the south of the Hawaiian Islands, yet the features in common existing between the two languages are many and quite apparent. Meeting a native recently from the Fiji Islands, who was of unusual intelligence and had a limited command of English, I gathered from him many things that were curious, touching this linguistic resemblance. I venture to give one, for the special reason of its double significance. In compar-

ing the terms used respectively in the Hawaiian and Fiji tongues to represent the several numerals, I found that there were two pronounced alike, and which, as a further coincidence, stood for the same values, viz.: Alua (three) and Alima (five). Now it so happens that both in the Hawaiian and Fijian languages, the latter term (Alima) is synonymous with that employed to designate the hand. The significance of this is apparent, indicating not only an allied structure of the two languages, but affording also a clue to the manner in which their numerical systems originated. In the incapacity of uncivilized races to form abstract conceptions, they naturally resort to the aid of concrete symbols; hence in their efforts at notation, the hand provides a ready and available record of numbers. Whatever may have been the origin of the terms used to express other numerals, it is quite probable, from the identity pointed out, that the open or full hand, with its five units, must have given rise to the name of that numeral, of which in practice it no doubt stood as a material symbol, representing that which to the sterile, untutored mind of a savage would otherwise have been an impossible ideality.

It is therefore to the close resemblance of

tongues, rather than to the confused mysticism of a mass of oral tradition relating to the early history of these islands, that we must look for the only satisfactory and reliable evidence by which a solution of the question of their origin can be reached. Were this line of comparative philology exhaustively continued, it would no doubt develop the fact that this great wave of humanity that has spread throughout the length and breadth of the Pacific had its origin in the remote regions of the East India Archipelago, or the eastern confines of Asia.

The total population of the Sandwich Islands was in 1873 somewhat less than 50,000. As Capt. Cook estimated, somewhat liberally no doubt, the number of inhabitants to be over 400,000 in 1779, some idea may be formed of the frightful decrease that has occurred among the natives in less than a century. Nor does this ratio of decrease in native population seem to diminish. There seems to be a steady and rapid decadence, which will in a generation or so work the final and complete extinction of this race.

This rapid decline in population will be realized in a more forcible manner by a glance at the vital statistics as shown in the census tables from 1832

to 1866. By the first official census, taken in 1832, the population had become reduced from the estimated number of Capt. Cook to 130,315. In 1836 it was laid down at 106,519, or a reduction of nearly 24,000 in the space of four years—an average annual loss of nearly six per cent. During the next 14 years the population suffered a further decline of only about 3 per cent. per annum, leaving for the census for the year 1850 a total of 84,100 inhabitants, of whom nearly 2,000 were foreigners. Within the next three years the loss was almost 12,000, leaving in 1853 a residue of 70,000 natives, a decrease of nearly 6 per cent. per annum.

The total population shown by the census of 1866 was 62,800, of which number more than 4,000 were foreigners. As the number of natives was estimated by the missionaries in 1823 to be 142,500, it will be seen that in the space of 43 years the reduction of native inhabitants amounted to some 84,000, or more than one-half the total population at the time of the appearance of the missionaries upon the islands. This decadence, though extremely rapid and preserving throughout this term of years seemingly a constant ratio, has however been checked to some degree, and for other reasons, rendering the ratio in a measure fictitious.

There is now in Hawaiian veins a large infusion of foreign blood. To so great an extent has this admixture gone that upon the older settled islands, except in the more remote districts, it is almost rare to find a native who does not exhibit by a well cut nose, a complexion toned down a shade or two, or a straightening tendency of hair, this amalgamation to a greater or less degree. As bearing upon the question of decline in population, this fact has a two-fold effect. In the first place, among the number classed in the census tables as natives, perhaps not over two-thirds are of pure, unmixed Hawaiian descent. In computing the ratio of decrease, it is evident that only that number comprising those of pure Hawaiian blood should be taken as the basis. Should this be done, the proportion of annual deaths would prove to be much larger than that given in the census.

As this dilution of native blood is increasing year by year in an inverse ratio, there occurs as a consequence each year a wider divergence from the real facts touching the proportion of decrease in the pure native population, as disclosed by the census tables.

As a second result to be considered, it must be borne in mind that this cross between the native

and foreign races has a tendency not only to add vitality to the resultant race, but also to produce a physical and mental organization in closer unison with the new conditions brought about by the introduction of the forms and usages of civilization. Were we therefore to confine all statistical comparisons to the pure native population only, that apparently constant ratio of decrease found to exist when contrasting the number of deaths with the whole population, mixed and unmixed, will be found a fictitious ratio, and much below the real one. Such an inquiry would no doubt show a steady and rapidly increasing ratio for the last 50 years.

Among the curious facts developed by the last census, and one of great significance, bearing as it does upon the important question of the reproductive power of the nation, is that the decrease in the female population is out of all proportion in excess of that of the male. In 1860, the total number of males in the islands was 35,379, and in 1866 it was found to be 34,395, a reduction of 984 during that interval. In 1860 there were over 31,700 females, which had become reduced to 28,564 in 1866, or a decrease of over 3,100 within the same lapse of time.

The causes which operate to produce this dispar-

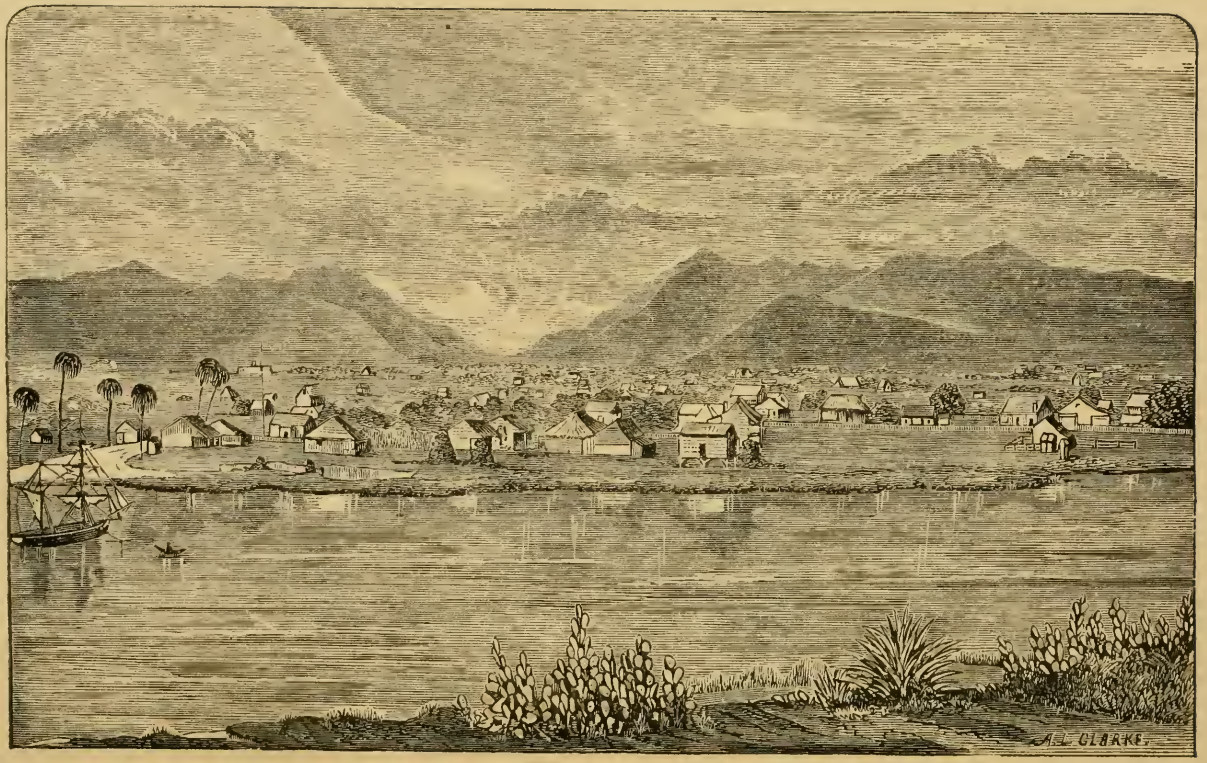
ity of result are probably many. I was however assured by the Governor of Maui—an intelligent native—that it was mainly due to the breaking down—through the agency of civilization—of an ancient "Tabu" which this people sacredly enforced, and which was admirably suited in its regulative and restraining influence to the organization and sanitary needs peculiar to the sex.

I cannot now speak of other specific causes that have been and are now in operation to produce the general result alluded to. I can only say that so far as my observation now goes, it is the effect of a general cause, to be found in the violation of one of nature's most inexorable laws—"conformity and harmony."

As the early philosophers used to say of a vacuum, that nature abhorred it, so it may now be said that nature abhors sudden transitions. Whatever may have been the immediate agencies by which this unprecedented mortality has been brought about, I feel justified in saying that the most general cause to which this result may be attributed is the too rapid civilization of the people. History does not perhaps furnish another instance where a race of people have as a mass been raised from a state of complete barbarism to an apparently high

civilization in the short space of 40 years. With all due admiration for the heroic self-denial and devotion with which the missionaries have urged on the work here, and a firm conviction of their purity of motive and honesty of purpose, I am yet convinced that the great error committed by them was in doing their work too well.

They have no doubt effected the complete and thorough evangelization of the island. Yet it is a fact patent to all, that concurrent with this result there has also, in some manner, been sown the seeds of destruction, which will, ere long, number the noble race of Hawaiians with the extinct tribes. Had I the time I could point out many customs and habits which, when forming a co-ordinate part of a long existing civilization, are salutary in their influence, but are here silently and swiftly sapping the vitality of this people, who have clothed themselves in the outward garb of civilization while yet retaining, both in body and mind, the elements of a barbarous ancestry. If the progress of enlightenment had been less brilliant and rapid here, I should have greater hopes of the future of this people.



HONOLULU--NUANU VALLEY IN THE DISTANCE.

CHAPTER XI.

Honolulu and its Environs.

Honolulu, the capital of the Hawaiian Islands, is located on the southern shore of the island of Oahu. It is in the midst of a beautiful, level valley, six miles long and four broad, around which a picturesque range of mountains curves in a regular semi-circle. It has about the only available harbor in the islands, and is of fair size, being reached through a narrow channel formed in the coral reef that surrounds all of these islands. It is irregularly laid out and has fine, clean streets, paved with blocks of coral and broken lava; and as there are few vehicles used here, they remain beautifully smooth and level and almost free from dust.

There are a few substantial business houses, built mainly out of hewn blocks of coral and sometimes of brick. The residences as a general thing are one story buildings, plain in style. Take it all in

all, it is the most attractive city I ever saw. It is, in fact, an immense conservatory. Flowers, rare plants and ornamental trees are found in the greatest abundance in the yards, public places—everywhere. The city is well watered by a stream of cool, fresh water which descends from one of the canyons back of the city, and several miles distant. There are about 10,000 inhabitants, of whom perhaps one-fourth are whites, mostly Americans, who entertain strangers with a cordial hospitality.

There are many objects of interest in the immediate vicinity of the city, enough to beguile away months. One of the most beautiful in the way of landscapes is the "Palli"—native for precipice—some six miles from the city. It is reached by a gradual ascent for the most part on the rugged, irregular bed of an old extinct crater; now thickly overgrown with trees and grass. At a height of 1,200 feet, the road suddenly terminates, and you are on the brink of a perpendicular wall of lava full 600 feet high, stretching away in a semi-circular sweep until it touches the ocean on either hand, enclosing a crescent-shaped plain into which you look as into a vast amphitheater.

The view so suddenly disclosed is one of infinite beauty and grandeur. To my mind there cannot

STREET SCENE IN HONOLULU.

be combined in a more attractive manner all the elements to constitute a complete picture. At your feet is the rugged wall of lava, pinnacled by jutting spires that look like grim sentinels; far in the distance is a long line of white foamy surf that marks the path of the ocean swell as it breaks over the reefs of coral; clouds of every form and hue spanned by the bright bow of a passing shower, rich, velvety leaves, gently rolling hills, clumps of palm trees, and the faint outlines of a distant village nestled among tropical trees, and everything that could enrapture the soul of an artist. How I wished for the gift of a Frankenstein, that I might put on canvas the matchless glories of this enchanted valley!

The soil of these islands is a marvel of fertility, and is merely disintegrated lava that has accumulated in different localities from 1 to 20 feet in depth. There is perhaps no other country in the world where there is to be found so much that is varied in climate, soil, vegetable production, et cetera. They are a complete world in themselves. There is no gradation of temperature but can be found here, from perpetual ice and snow down to an unvarying tropical heat. As the soil contains almost every constituent necessary to vegetable

growth, as a consequence of the extreme diversity of physical conditions, a profusion and variety in the vegetable world is to be met with that is bewildering.

The climate is just as one will have it, as there can be found somewhere in the islands a climate that would suit the native of any zone, from a Laplander to an Ashantee. If the temperature and humidity of the air be not such as suits one in the valley, you can move up a mountain a mile or so, until you find, if you desire it, perpetual spring, perpetual summer, perpetual winter, perpetual drought, or, if preferred, perpetual rain. To one accustomed to the variable and treacherous climate of Ohio, there is something indescribably fine in the constancy of the weather, in whatever section you choose to locate. Here one rises in the morning without ever giving thought as to what kind of weather the day will bring forth, feeling certain that it will be a repetition of the same sunshine, the same gentle showers and balmy breezes that have prevailed for months.

The following table of temperatures will more clearly show the average and extreme range of thermometer, in the city of Honolulu, comprising a record for eight months. It may be added

that during the remaining months of the year, the thermometer scarcely ever indicates a higher temperature than 90 degrees, and the extreme daily variation in temperature very rarely reaches a higher average than 12 to 15 degrees.

Extreme Range.—In	October,	72 to 86	degrees.
"	November,	66 to 86	"
"	December,	70 to 85	"
"	January,	60 to 85	"
"	February,	62 to 82	"
"	March,	65 to 84	"
"	April,	62 to 84	"
"	May,	70 to 87	"
Average Range.—In	October,	75 to 84	"
"	November,	73 to 84	"
"	December,	72 to 82	"
"	January,	66 to 82	"
"	February,	68 to 80	"
"	March,	70 to 82	"
"	April,	70 to 82	"
"	May,	74 to 84	"

Although there are in the seasons of the islands periods that might be termed wet and dry, yet they have not that well-marked periodicity which characterizes climatic changes in America.

The rain-fall varies exceedingly, even between

localities on the same island, and in a more marked manner between the various islands. Near the sea-shore, on the leeward side of the island, as at Waikiki, the annual rain-fall scarcely ever reaches 37 inches, while at a distance of less than a mile and a half further inland, the amount sometimes exceeds four feet; and still further up the valleys, say four or five miles, where the cooler temperature and the moisture-laden trade breezes combine to produce an almost continuous succession of showers, the rain-fall sometimes amounts to more than 100 inches annually.

The causes tending to modify the climate here, unlike that of our country, are few and uncomplicated. Hence the simple character of meteorological phenomena. There is but one prevailing wind here, blowing invariably from the same quarter—the trades—so that all of variation in Hawaiian climatology is mainly due to the slight modification of temperature incident to the change of season. This is so slight as to have scarce an appreciable effect. I believe there is no country equal to these islands in the combination of favorable conditions for the extreme development of vegetation—plenty of sunshine, regular showers, and soil of exceptional fertility. It is no wonder, therefore,

GIANT OR PULU FERN.

that we find here that the whole scale of nature has taken a leap forward, so that lichens become mosses, mosses become ferns, and ferns become trees.

Speaking of ferns, this is truly the home of the fern, and any one who can see the acres of exquisite ferns without contracting the fern fever has no eye for beauty. There are on these islands several hundred varieties, many of which are of surpassing beauty, rivaling in delicacy of texture the most dainty patterns of lace. The size to which some of these ferns grow is truly wonderful; to use a "Paddyism," it is almost risking one's veracity to tell the truth about them. The "Pulu" fern, which is found mainly on the island of Hawaii, grows to the extraordinary height of 30 to 40 feet. It sends up a main trunk and in general appearance is not unlike the palm.

It is from this fern that the beautiful soft, silky substance is procured, which forms to some extent an article of commerce. It is found in closely compressed clumps or masses within the space formed by the junction of the main fronds with the trunk of the fern. A quantity varying from ½ to 4 pounds, according to size of plant, is taken from a single fern. It is much used in the islands for bed-

ding and general upholstery, and is exported quite largely for the same purpose.

I have myself seen the body of this fern over two feet in diameter, and I am assured that they sometimes attain to even 6 feet in diameter. It is no unusual thing to see leaves of this variety full 20 feet long and 6 to 10 feet broad.

Among the more remarkable vegetable productions, the Taro must take rank as of first importance, by reason of its economic value. What rice is to the Chinese and the East Indians, wheat and corn to the American and European, and potatoes to the Irish, the Taro is to the Hawaiian. It is preeminently the national food, and no doubt to this esculent must be attributed the rise and growth of the exceptionally dense population found to exist in the first discovery of the islands.

As the area of the islands is 6,000 square miles, and as the population at the time of discovery was about 400,000, this will give, as an average for the whole group, nearly 70 persons to the square mile, —a remarkably dense population, having over three times the average density of the population of our own country. As the extent to which the earth is capable of sustaining a population is limited only by the perfection of the arts and sciences

THE TARO PLANT.

which are brought to bear upon agriculture, it follows that the more nearly a race approximates to a state of savagery, so in direct correspondence does their means of subsistence become more restricted and precarious.

As the culture of almost all vegetables used as an article of food presupposes some degree of agricultural knowledge and skill, it becomes apparent that the more barbarous and primitive the condition of a people, the more they become dependent upon the uncertainties of the chase as a means of subsistence. It is due to this fact that countries inhabited by savage tribes have uniformly a very sparse population as compared with civilized countries, as the increase of the population of a country is in perfect unison with the facility with which food can be procured.

Now as there is no good reason to believe that the ancestral Hawaiian was of a less nomadic nature, or possessed of greater habits of industry than his average savage brother, the world throughout, we are led to suspect that the advantages which gave rise to such unusually large increase in population were to be found in the readiness with which some natural production yielded to him an abundant, certain and easy support. This in real-

ity is found to be the case, for I am sure that no vegetable in the world can be made to yield so large a quantity of nutritious substance for the same expenditure of labor as the Taro.

So easy of culture, so productive is it, that I believe the labor of one-half hour in the day would be sufficient to supply enough of it to sustain the life of an average man. The plant belongs to the *Aurum* family, which includes the Indian turnip, calla &c., to which latter the leaf of the taro bears a very close resemblance. The root varies from 1 to 8 pounds weight. Formerly it was grown entirely in low tracts which were inundated at regular intervals; but it is now often grown in upland places, equal in quality and little less in quantity. The necessities of its culture gave rise in early times to a very extensive system of water-ways and irrigation, the ruins of which magnificent specimens of savage engineering are yet to be met with all over the islands.

The root is of the most nutritious character, containing an unusually large proportion of starch. The natives, in preparing it as an article of food, first excavate a hole in the ground, which they fill with stones. A fire is then built upon these stones, until sufficiently heated, when all but a single

BEATING POI.

layer at the bottom is removed. The broad, smooth leaf of the Ke plant is then spread over the bottom, upon which is placed a proper quantity of the roots. This is covered with another layer of leaves, when the whole is completely covered with heated stones. By this means the roots soon become thoroughly cooked.

I ought here to add that this is the system of cooking throughout the islands, and is the manner in which their dainty dishes—notably roast dog and pig—are prepared.

After the taro has been sufficiently baked, it is beaten in a rude mortar, or shallow wooden dish, by a stone pestle, into a thick dough. This is afterward mixed with water in sufficient quantity to form a semi-liquid paste, which is set aside to undergo partial fermentation. In a day or so it acquires a slight acid taste, somewhat resembling yeast. It is now ready for use, and is called by the natives "Poi," requiring no further preparation to be eaten.

Although the root itself is white, it acquires, when mixed with water, a slight bluish tint, which is doubtless owing to the traces of iodine contained in the water, which acts chemically upon the starchy substance of the root. It is not acceptable

at first to an American palate, but by use a fondness is quickly acquired for it.

The manner in which the natives eat this food is at once unique and diverting to a foreigner. Surrounding a calabash in which it is contained, each one in turn inserts his finger into the mass, to which adheres a good sized lump, which with a dextrous jerk is whipped into the mouth and off the finger. There is generally, also, to make the repast complete, a dish containing a few raw fish, which they eat as a sort of relish, each one in turn tearing off a morsel of this dainty substance, which is not calculated to provoke an appetite in an American, either by its looks, taste or smell, yet doubtless to the practiced palate of a Hawaiian is deliciousness itself.

The Taro root resembles very closely that vegetable popularly called in our country "Indian turnip," and produces while raw the same burning, pungent effect upon the tongue when eaten, but entirely loses this property when heated.

In view of the ease with which it can be cultivated and its immense yield per acre, together with its remarkable nutritious qualities, as well as the peculiar properties that render it specially wholesome in warm climates, it would certainly become,

EATING POI.

if introduced into this country, the most valuable addition yet made to our esculents, as it would without doubt furnish an abundant and cheap food for the colored population in the South. There are, I am sure, large districts in Florida, Georgia, Alabama, Louisiana and Texas, where it could be cultivated with ease and certainty.

At Waikiki, some three miles from the city, is a very pleasant bathing place. It was the sea side resort of "Kamehameha Fifth." As this royal Kanaka kicked the beam at something over 400 pounds, it became a matter of much concern as to how all this royal substance could be transported with the least discomfort to his ponderous majesty. To this circumstance the tourist is indebted for the privilege of reaching Waikiki by a pleasant drive over one of the finest roads I ever met with. It ought to be good, for it is about the only road in the entire kingdom. Inter-transportation is effected in all the islands by ponies and donkeys. The surf here is fine and as the water is deliciously warm, bathing becomes here a luxury indeed. I saw at this place for the first time, that famous sport of the natives, "surf bathing." As the Pacific Ocean has here an uninterrupted sweep from the south of several thousand miles, the swells roll in with pro-

digious force, dashing the water into immense snowy fleeces. The native takes a small plank a foot wide and a few feet long, and by adroitly diving under the approaching waves, at length works his way far out to sea. Watching his opportunity on the approach of an unusually heavy surf, he dextrously flings himself into it a little forward of the crest, slightly inclines the board to receive the forward impulse of the water,and with the speed of the wind rushes toward the shore, enveloped in a fleecy foam and spray. I did not try my hand at it, as I learned that to succeed required long years of practice, and it is rare to find, even among the resident whites, one who is equal to the feat. It is the most exciting sport I ever witnessed.

In the distance, projecting its clear, well cut, serrated edge against the blue sky, rises an isolated peak called Diamond Point. It is a long since extinct volcano, about one thousand feet in hight, having in its summit what is said to be the most symmetrical crater in the islands, forming a regular, almost circular cavity, like a huge punch-bowl.

I had while at Waikiki an opportunity of more carefully inspecting the canoes of the natives, which I had so often seen at a distance, dancing with their sable crews like mere dark specks on

VIEW OF WAIKIKI AND DIAMOND POINT.

the snowy crest of the waves. They are constructed mostly out of a very firm hard wood called "Koa," and sometimes of a wood closely resembling it, called the "Kou." They are of extreme length as compared with the width, so narrow in fact that a man of good proportions would have to limit himself to a very frugal dinner if he preferred to sit down, rather than be compelled to stand up like a "Colossus of Rhodes" in one of them.

They would be no doubt completely unmanageable, were it not for a device employed on all the canoes of the South Seas, which is called an outrigger. Springing from one side of the boat are two long curved pieces of wood, one end being lashed to the canoe by a kind of cordage made from the fibres of the Lauhalla, and the other just dipping beneath the surface of the water. Connecting these two pieces at their ends, and lashed in a similar way is a piece of very light, porous wood called "wili wili," which floats upon the surface of the water at a distance of about ten feet from the side of the boat, adding greatly to its stability.

Even with this addition, it is yet unfit to be used for purposes of navigation by any less skillful gymnast than a Blondin, for I am certain an ordinary man would feel quite as safe and comforta-

ble, and would have no greater difficulty in preserving his balance, were he to attempt to navigate the Atlantic in a butter-bowl. Yet the bold manner in which the natives plunge out into the roughest seas, and the skill with which they manage these light, treacherous craft, even in a raging surf, is a marvel to behold.

In fitting out a fleet for warlike purposes, it was once their custom, in former times, to lash quite a number of these canoes together, side by side, rendering outriggers unnecessary, and thus forming a kind of compound boat, of considerable capacity and quite serviceable. It is said that Kamehameha 1st made his tour of conquest among these islands in boats constructed in the manner described.

The Legislature being in session, we dropped in to take a look at the sable law makers of Hawaii. Heretofore there has been a goodly sprinkling of whites in the Legislature, but from a growing feeling of distrust on the part of the natives, the last election returned natives almost exclusively, there being, I believe, only two exceptions. I was much pleased with the appearance of the members, it being physically the finest body of men I ever looked upon. They have a cultivated, intellectual

SURF-BATHING.

appearance and almost without exception well formed heads. As the discussions were carried on in the native tongue we could learn but little of the nature of the business pending. Things are not altogether lovely here, and the wheels of government are grinding. There is, in short, a tempest in the political teapot, for, be it understood, political intrigue here, as in more civilized communities, is insidiously fomenting discord and trouble in the body politic. It is the same old story, a strife between the ins and the outs.

All the salaries are regally munificent, and therefore there is much contention for high places; and as at each succession a new deal takes place, it can readily be seen how easily trouble and disorder may arise. This is especially true when in each contending faction there is a nucleus of ungodly, unprincipled adventurers as the chief wire-pullers. Upon the death of the late king Lunalilo, the adherents of Queen Emma sought to place her on the throne, and those who espoused the cause of the so-called rightful claimant as stoutly resisted. A first-class row ensued, in which the palace and halls of legislation were badly damaged, and was only prevented from assuming a dangerous form by the timely interference of an Ameri-

can and English man-of-war. Kalakaua, the present king, is said to be much prejudiced against the whites—for what special reason I know not—and his whole policy is such as to favor the natives. From what little I have observed of the officious intermeddling by the whites in Hawaiian affairs, and the many abuses practiced, I do not wonder that the natives have at last, though tardily, come to realize the scheme of plunder and extortion of which they are the victims, and that they have become suspicious, even to an unjust degree, of the Anglo-Saxon.

CHAPTER XII.

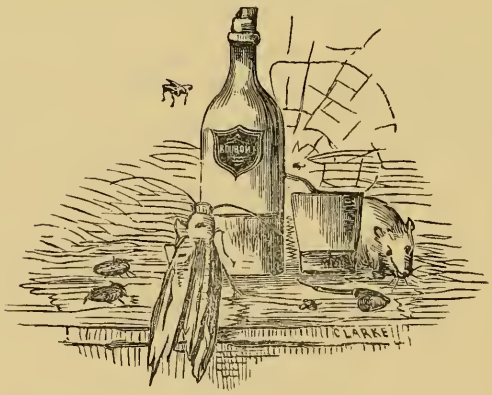
A Trip to Maui.

We had been preparing for some days for a tour of the islands of East and West Maui, on which the great crater of Haleakala (house of the sun) the largest crater in the world, is located. As the remaining tour of the islands can be made only on horse-back, we took the precaution to invest in three good saddles at Honolulu, as we were told that it was difficult to get them on the other islands. We also secured the services of an intelligent native—"Antonie"—who accompanied us on the remainder of our tour through the islands.

There is a small steamer of 300 tons that usually plies among the islands, but unfortunately for us it was just now undergoing complete repairs, and would not be in a condition to sail for some weeks. As we had not the time to spare, we were compelled, much against our wishes, to make the trip in an old dirty Kanaka-manned schooner that is used to carry freight from Maui to Honolulu. On

inquiry as to how long it would take us to reach Lahaina in this craft, we were answered that it depended upon circumstances whether we reached there in 30 hours or a week. Altogether a question of wind.

After taking a careful look at it, I became con-



OUR TRAVELING COMPANIONS.

vinced that it was a matter of divine intervention, also, whether we reached Maui at all or not in it. However, as it was the best we could do we shipped in the crazy craft. As we had on board a dozen of sweet-scented Kanakas, a bushel or two of cock-roaches, more or less, and as there was a vertical sun that blistered the deck, and as we

THAT SCHOONER.

had 80 miles of the roughest waters of the Pacific ocean to cross—Oahu channel—it is needless to say that we slept soundly, ate our meals regularly and were truly happy.

We had no sooner rounded "Diamond Point" than I retired below. I did not go below because I preferred it, but because I could not swim very well. Our cabin was indeed a commodious affair, fully as high as a cigar box, and of such ample width that you had to go on deck to turn around. Our captain was a true gentleman, and familiar with the usages of good society. He recognized the importance of rigidly maintaining those fine social distinctions necessary to preserve the reputation of a metropolitan passenger ship. He therefore, with delicate discrimination, resolutely excluded the Kanakas from our aristocratic quarters.

It is well that he did so, as with the fleas, mosquitos, cockroaches, the heat and the surging of the boat, an addition of a few dozen natives might have imparted a bouquet to the balmy air that would have seriously interfered with our perfect happiness.

A rare old vessel was this schooner. She was something like one-fifth as broad as long, and about as long as Deffenbach's Fourth of July om-

nibus. She was none of your boats that sail round Robin Hood's barn. Oh no! She never took the trouble to go over a wave. She always went under it. This must have been interesting to the natives on deck, and I am morally certain they were surf-bathing half the time.

She was a nice old sailer. She could sail as well on beam's end as with her bow sighting fifty degrees above the southern cross. She could sail as well under water as above it, in fact she seemed to prefer it. At first I felt alarmed at being submerged so much. But I soon saw there was no real danger and quickly calmed my fears when I discovered that she came up regularly every half hour or so to blow.

Circumstances were propitious, and after thirty mortal hours of pitching and surging, we at last reached Lahaina, to our inexpressible relief—the sickest, slimiest, sourest looking trio of pilgrims that ever journeyed. As a developer of ocean horrors, commend us to a Sandwich Island coaster.

Maui, the third island in size, has about six hundred square miles, and is divided by a low, sandy plain—once the bottom of the ocean—into East and West Maui. On West Maui is the finest range of mountains we have yet seen, bisecting the island

from east to west, rising to the height of seven thousand feet. These islands, as is usual with the whole group, rising so abruptly, are scored from summit to base with numbers of deep parallel valleys, clothed with the densest verdure, giving them at a distance an indescribably beautiful effect.

In company with the Governor of the island and several white gentlemen, we visited the Oloaulu valley, some four miles from Lahaina. The trail by which we enter the valley for the first mile wound along the banks of a beautiful, sparkling stream, that came leaping down from the rocky fastnesses above, where, in the shadows of eternal clouds that envelop the mountain's summit, it has its source. A ride of two miles brought us where the valley suddenly terminates in a canyon. Our route now may be said to literally lie in the bed of the stream, as in the distance of one mile and a half we crossed it fifty-seven times. For all that is wild and terrific, the scenes that constantly unfolded as we advanced up this terrible gorge surpassed anything I have ever seen.

In many places the canyon narrowed down so that by extending his arms one could almost touch the opposing walls at the same time; the black, rugged walls of lava rising almost perpendicular

from 3,000 to 4,000 feet, shutting out all but a narrow belt of blue sky far above our heads. Suddenly we would emerge into a small circular space covered with a dense grove of Kukui and Coa trees, through the tops of which we could catch glimpses of many waterfalls, leaping down from heights of 1,000 to 2,000 feet in a long line of silvery spray. Then again we would plunge into the prison-like gloom of these eternal rocks. We thought we had before performed some difficult feats of horsemanship, but this for rough riding was a little ahead of anything we had dreamed of.

The steep inclines of bare rock we ascended, the piles of boulders over which our horses floundered, the yawning chasms along the very verge of which we threaded our way, made it altogether a most perilous trip. Putnam's feat is commonplace compared with it. The natives and most of the party dismounted and abandoned their horses, but the Professor and myself, with perhaps more pluck than discretion, stuck to our animals and rode the trip throughout. The angles, curves, and perpendiculars we described on this journey I cannot give. The Professor has some data, and if he don't exhaust his mathematical resources will work them up.

NATIVE GRASS HUT.

Two miles and a half from Laihana, near the shore, is a large, level, sandy plain, composed of drifted coral sand as it has been ground up by the action of the waves. Tradition has invested this plain with a peculiar interest. It is said to be the scene of the final battle between "Kamehameha first" the old Hawaiian chief who effected the unification of the islands, and the petty chiefs of Maui. Many are the blood-curdling stories told of the dreadful havoc and carnage, and how the gallant sons of Maui were at last overwhelmed, and such as were not destroyed on the field of battle were crowded into the sea. Much of course is mere tradition, but if acres of grinning skulls and bones as thick as snow-flakes be any evidence, I should say that they had more than a mere skirmish here.

Taking with us a native or two and several baskets, we set out to explore this Golgotha. It was a strange sight to see the white bleached bones scattered over many acres so thick that you could almost step from one to the other. What a fearful sight it must have been when naked barbarians with mere clubs and spears of shark's teeth slaughtered one another in such prodigious numbers.

Happily the benign influences of civilization

have long since put an end to these dreadful scenes, and have, in fact, rendered wars unnecessary. Things are different now. The natives do not now cruelly beat one another with clumsy war clubs, or rasp the flesh from one another's bones with long, hideous serrated pikes, but they are silently and quietly dropping into their graves by thousands from the milder and more refined influences of an enlightened morality and—forty rod whiskey.

After throwing the bones of a few dozen chiefs about in a confused, irreverent manner, we at length secured a specimen remarkable for its perfect state of preservation. We returned to box and ship him at once to Honolulu, as the Kanakas, having a deep-seated superstition about the dead, would certainly destroy the most perfect specimen if left long within their reach. It is singular how little charm scientific matters have for these fellows.

At Lahaina-luna, about one mile back of the city, on the slope of a mountain giving a commanding view, is one of the oldest schools in the islands. It is a select institution, as it is here that Hawaiian youths of noble extraction receive their education. The school is, as all on the islands are, under the

control of the Board of Foreign Missions.

Further up the mountain slope is a lovely spot—Mont Retreat—much frequented by the inhabitants of the islands, on account of the delicious breeze always found there, and the thousand charms of its sequestered nooks, groves, ravines, and endless quantity and variety of flowers, ferns and mosses.

In company with a most estimable lady—Mrs. P. Norton McKee, whom we shall always remember with rare pleasure for her many acts of kindness and assiduous endeavors to make our stay at Lahaina a pleasant one—and a young gentleman, the Sheriff of Maui, Mr. W. C. Smith, we spent many hours of the most delicious enjoyment in this little paradise.

Its elevation is nearly 3,000 feet above the ocean, giving to the south and west a wide range of view. The island of Lanai, with its reddish volcanic tint, lay before us, and the rich green foliage on the island of Molokai was plainly discernible, some eight miles to the right of us. This island is said to be one of the most beautiful and pleasant of all the group, containing a variety of landscape scenes, mountain views, beetling cliffs, and waterfalls, not excelled by any of the other islands.

From the impression created by our view from this distant and lofty point of observation, we longed to get a nearer view of the beauties that lay so temptingly before us.

But this is a forbidden land. A shadow of death covers the island. It is not to be understood that the gates of the island are literally closed against the foreigner, but one is very certain to give it a wide berth from choice, when he learns of the pestilential horrors that infest this whited sepulchre, this charnel-house, this prison island for the loathsome lazars of a leprous nation.

Among the many destructive agencies which the blighting hand of civilization has fixed upon this doomed people, perhaps the worst of all is the introduction into the current of Hawaiian blood of a polluting stream of leprosy. This is at once the most fatal and loathsome of diseases. So far, medical science and skill have been alike powerless either to arrest its growth or effect a single cure. It is not however regarded now, as formerly, of a highly contagious nature, but on the contrary it is believed that its propagation is effected by little short of absolute inoculation only.

The first evidence of the disease is local insensibility, generally of some portion of the face, often

the hands and feet, and sometimes the lobes of the ears. This is soon followed by a discoloration of the skin, which becomes mottled by pale irregular splotches. In the last stages of the disease, the flesh literally dies upon the body, the poor victim losing successively the fingers, arms and legs, which slough off in the most horrible manner, frequently before death supervenes. There is but little pain usually accompanying this gradual dissolution, the patient moving about and seemingly enjoying life even to the last moment.

When and in what special manner the disease originated, or was introduced among these ill-fated islands, no reliable information can be gathered. So long, however, has it existed among the people that it has become a fixed taint upon their blood, assuming even to some extent a hereditary form.

With a view of checking its further diffusion among the people, the government has set apart the island of Molokai as a sort of retreat or general hospital, to which the patients are sent and confined as fast as the disease is found to develop. Even with all the dreaded horrors of this plague before them, the natives have a strange insensibility to danger, taking no precautionary pains against it.

There are now confined on the island over 900 persons so afflicted. But as these are all well-marked cases, and as the disease is slow to develop, being difficult to detect in its incipient stage, there are large numbers, doubtless, on all the islands in whom it exists in a nascent state, which is certain to develop sooner or later. While at Lahaina, I saw several in whom the primary stage of the disease had recently developed, and who were being prepared for transportation.

As the native population is less than 50,000, it is safe to say that at least one in 40 has this leprosy either in its active or incipient stage—a proportion so frightfully large as to well fill the mind with the gloomiest apprehensions. It will be proper, however, to add that so far the disease has been almost wholly confined to the native class, only two authenticated cases, I believe, having yet occurred among the whites.

At Wailuku, on the opposite side of the island, we found the most highly cultivated and altogether the most desirable section we had as yet visited. The soil here is of surpassing fertility and of great depth; I doubt whether there can be found anywhere else in the world a soil of such rare fertility. Here is the center of the sugar interests of the

SCENE ON THE SHORE AT MAUI.

islands, the finest plantations being found in the valley. Here you see stretching away for miles nothing but dense green fields of sugar cane of wonderful growth. Here the inhabitants talk nothing but "sugar, sugar." The very air is laden with the saccharine vapors that rise from the many mills scattered throughout this pleasant valley. Even the very "lasses" look sweet.

I had heard many wonderful stories about the sugar-producing capabilities of these islands, and of course thought them highly over-wrought. In our own country, I believe, from ¾ to one ton of sugar to the acre is thought a good yield.

But here the planter is not satisfied if he does not realize from two and a half to three tons per acre. What would an American sugar planter say to a yield of seven tons per acre? Yet this amount is often taken from the lands here. Nor is this merely an exceptional production of a few choice acres only, for it is not infrequently the yield of quite large tracts of land. I myself saw at the West Maui Association cane that was being worked off of a tract of land nearly twenty acres in extent, that was yielding between five and six tons per acre. This was from cane of twenty months' growth.

The cane does not ripen here as in our own country, but continues to grow for several years, constantly improving in quality. The cane is mostly grown by irrigation on this side of the island, the Wailuku river furnishing an abundance of water for that purpose. The crop here is always certain, there being no frosts to endanger it, and it is not subject to any other casualty. The planter, therefore, keeps his mill in almost continuous operation, working off his crops at his leisure.

As fast as the cane is worked off of say 100 acres, it is immediately replanted, (rattoon being now almost abandoned,) so that by the time 800 or 1,000 acres has been worked over, the replanted cane is fit for the mill.

The following list of the various plantations throughout the islands, with their average annual production and maximum capacity of mill, will give some idea of the extent to which this important branch of industry has been developed. The plantations enumerated are, it will be seen, producing only about one-half the quantity that the mills are capable of turning out. This is attributable to the scarcity of labor, which year by year is becoming a more serious obstacle to all industrial enterprises.

The cause of course is to be found in the continuous decrease of native population, already pointed out. This growing scarcity of laborers is however in a measure repaired by the yearly growth of the Chinese population, the immigration of which race, as in our own country, is greatly on the increase.

On Hawaii there are nine plantations, of the following yield and capacity:

	Average Crop.	Capacity of Mill.
Kohala plantation,	600 tons.	1,000 tons.
Onomea "	500 "	1,000 "
Kaupakuea "	500 "	1,000 "
Spencer "	500 "	1,000 "
Paukaa "	300 "	500 "
Kaiwiki "	400 "	600 "
Kona "	100 "	200 "
Kau "	150 "	200 "
Kaaiaha "	100 "	200 "

On the island of Maui there are eleven:

Ulapalakua plantation,	800 tons.	1,200 tons.
Pioneer "	1,000 "	1,200 "
West Maui "	600 "	1,200 "
Waikapu "	500 "	800 "
Waihee "	1,000 "	1,200 "
East Maui "	500 "	800 "
Haiku "	650 "	1,200 "
Hana "	250 "	400 "

	Average Crop.	Capacity of Mill.
Union Mill plantation,	300 tons.	600 tons.
Hobron "	300 "	400 "
Mokaweo "	400 "	600 "
On the island of Oahu there are six:		
Kaueohe plantation,	100 tons.	250 tons.
Heela "	200 "	400 "
Kaalaea "	400 "	1,000 "
Halawa "	60 "	200 "
Waialua "	100 "	200 "
Laiea "	100 "	250 "
There are only four on the island of Kauai:		
Leihue plantation,	400 tons.	1,000 tons.
Koloa "	250 "	500 "
Princeville "	400 "	1,000 "
Waipa "	100 "	200 "

The culture of sugar was first attempted on these islands in 1820, but it was not until 1844 that sufficient progress had been made to enable it to become an article of export. In that year there was 200 tons sent abroad. How rapid has been its development since, is shown by the fact that in 1871 there was 21,760,700 pounds exported.

The sugar interests of these islands are yet in their infancy, the resources being scarcely touched, as barely 10 per cent. of the lands suitable for sugar are now cultivated. The expenditure of a small amount of money would in many places

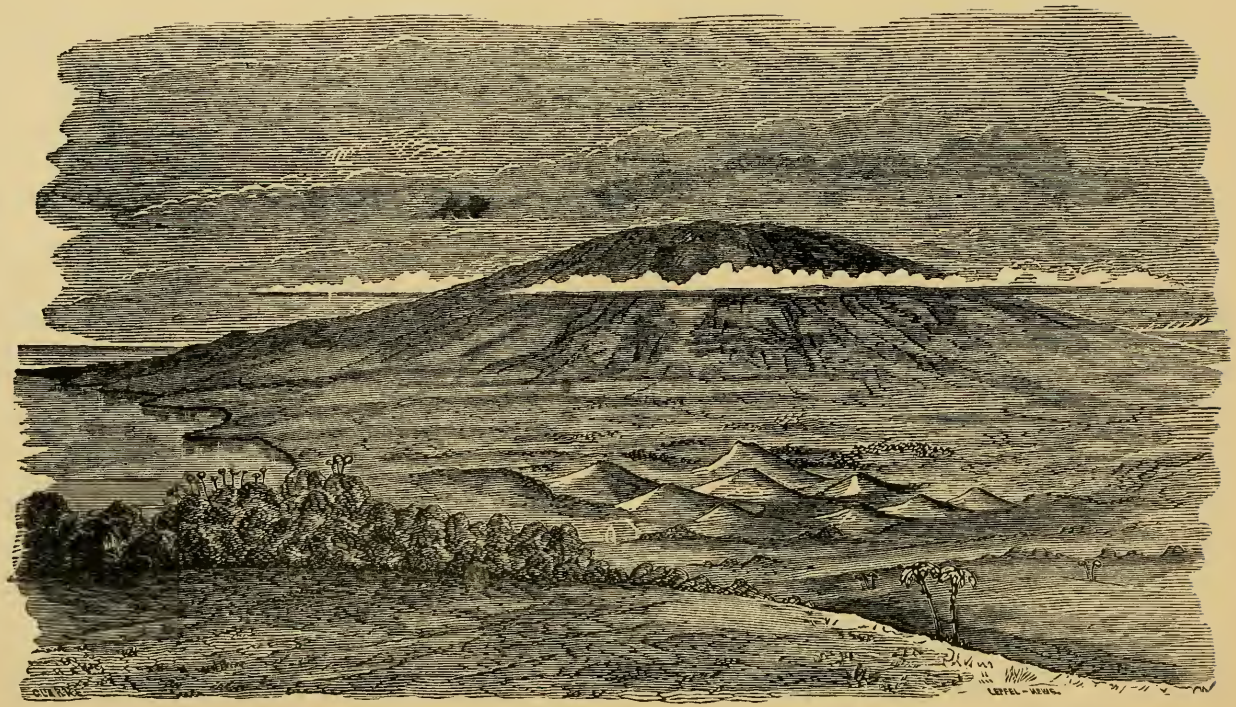
open out large tracts of as good land as those now under cultivation. On East Maui I am assured that the expenditure of a hundred thousand dollars for a canal to bring the water from the summit of Haleakala would reclaim forty thousand acres of land, which would yield from two to four tons per acre.

The sugar interests here are just now under a cloud, low prices being the cause, I am told. It however seems to me that with all the advantages they have here, the certainty of the crop, the astounding yield per acre, and labor at 37½ cents per day, they ought to successfully compete with our own planters, even though they have three cents per pound duty in their favor.

The Iao valley, some two miles from the city, is one of rare beauty. It is easily reached by a pleasant ride along a clear, rapid stream that comes rushing down its sinuous rocky channel, the banks of which are checkered with native "taro" patches, and covered with masses of rare and fragrant flowers. As you advance up the valley, the mountains increase in height, sloping away on either hand, at a gentle incline, to an elevation of 6,000 to 7,000 feet.

Mosses, ferns and kukui trees spread their green

unbroken mantle over these mountains from summit to base, giving them an effect, when contrasted with our own mountains and their meager vegetation, that is impossible to describe. The terminus of the valley is in a vast amphitheatre, bounded by impassable "pallis," thousands of feet high, in the midst of which is a solitary pinnacle of rock, full 1,500 feet high. It looks as though it might be a splinter cleft by some Titan from the frowning cliffs above, and hurled into the valley below. To faithfully transfer to canvas the beauties of this enchanted valley would immortalize any painter.



VIEW OF HALEAKALA, 25 MILES DISTANT.

CHAPTER XIII.

The Crater of Haleakala.

From Wailuku we have a very fine view of the grand old mountain of "Haleakala." It is located on East Maui, some 30 miles distant, and constitutes in fact the whole island. This is perhaps one of the most remarkable mountains in the world, even though we do not take into account that the largest crater on the globe is to be found on its summit.

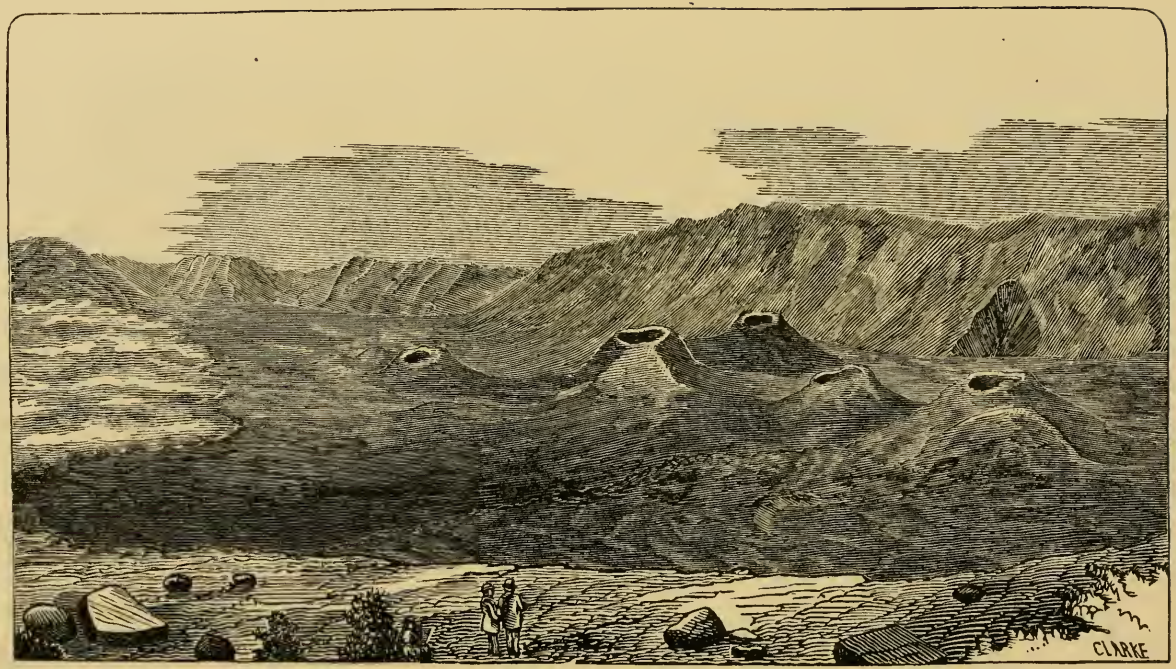
There are mountains much higher, but as they rise from the apparently level surface of a plain which may constitute the greater portion of the elevation, one is not impressed with the idea of great height. But this mountain rises right before you, a complete, symmetrical cone, right out of the ocean, and you can see at one glance every inch of its height, from the summit that is wreathed in a belt of snowy clouds to the very ocean whose waves dash against its rocky shores. It is about

40 miles in diameter at its base and 10,200 feet high. Along its gently sloping sides are thriving villages, dense fields of cane, coffee groves, and everything that betokens a happy and prosperous community.

To see the crater of Haleakala is to see perhaps the finest sight on this globe, so we impatiently journeyed thither.

Mokawau, where we spent the night and made preparations for our ascent, is on the northern slope and 2,000 feet above the ocean. From this place to the summit is a distance of 12 miles. As the journey usually occupies two days, and as it is very cold on the summit, we provided ourselves with a complete outfit of camping utensils, blankets, &c. Early one bright morning we set out on our journey.

The first five miles lay over a trail much worn by bullock hunters, and not of very steep incline. Diverging suddenly into an almost unbroken trail, we soon began our real ascent. The distance now being near seven miles, and over 7,000 feet to ascend, the path became quite abrupt; in many places of a grade fully 2,000 feet to the mile. The trail is rough—awful rough is the word—being over the rugged, broken surface of old lava flows,



CRATER OF HALEAKALA.

upon which, in occasional patches, is a stunted growth of grass and scraggy shrubs.

At the height of 7,000 feet we struck the clouds. At first they were merely thin, vagrant masses of fog which came suddenly drifting over us, and as suddenly disappearing again. In a few minutes, however, we were in the midst of real clouds—the same clouds we had so often seen from the earth, high above us, piled up in white, billowy fleeces. They soon became so dense as to shut out everything, and made it a matter of somewhat skillful engineering for our guide to keep in the trail. The stratum of clouds was about 2,000 feet thick, as I found by my barometer. We were over an hour passing through them, and finally emerged into the bright sunshine above, quite wet from our aerial bath.

We were at last above the clouds, and what a beautiful sight! Stretching far away, filling the whole heavens *below*, they looked like an endless field of snow, dazzlingly bright under the reflected light of a clear tropical sun. We were now looking down upon the clouds from a distance of nearly half a mile, and through breaks in them we could catch occasional glimpses of the valley far beneath us. It was a curious picture, this strange comming-

ling of sea, valley and clouds in one common plane. We could look over the extreme verge of the clouds and see the islands and ocean beyond.

We do not approach the crater gradually, but come upon it in the most sudden manner. Riding to the very edge it burst upon us with a suddenness that was startling, since we were not expecting it, the slope for the last half mile being quite gradual, and nothing to indicate our near approach to it. The whole interior surface of the crater has a burned, reddish appearance, and looks as fresh as though its fires had been hushed but yesterday. My first feeling when looking into the crater was one of regret that we had not arrived an hour or two sooner, as the show seemed to have just closed. I could not suppress the thought, when looking into this fresh scorched and seared cavity, that Pluto had only stepped out for a friendly afternoon's call upon Madam Pele, at Kilauea, and we had improved the occasion to take a surreptitious peep into the awful mysteries of his now silent workshop.

Here indeed was a crater worthy the name. Vesuvius is a little pimple about 3,000 feet high, with a little dent in the summit called a crater, 300 feet deep, and 1,000 feet in diameter. But

MAP OF THE CRATER OF HALEAKALA.

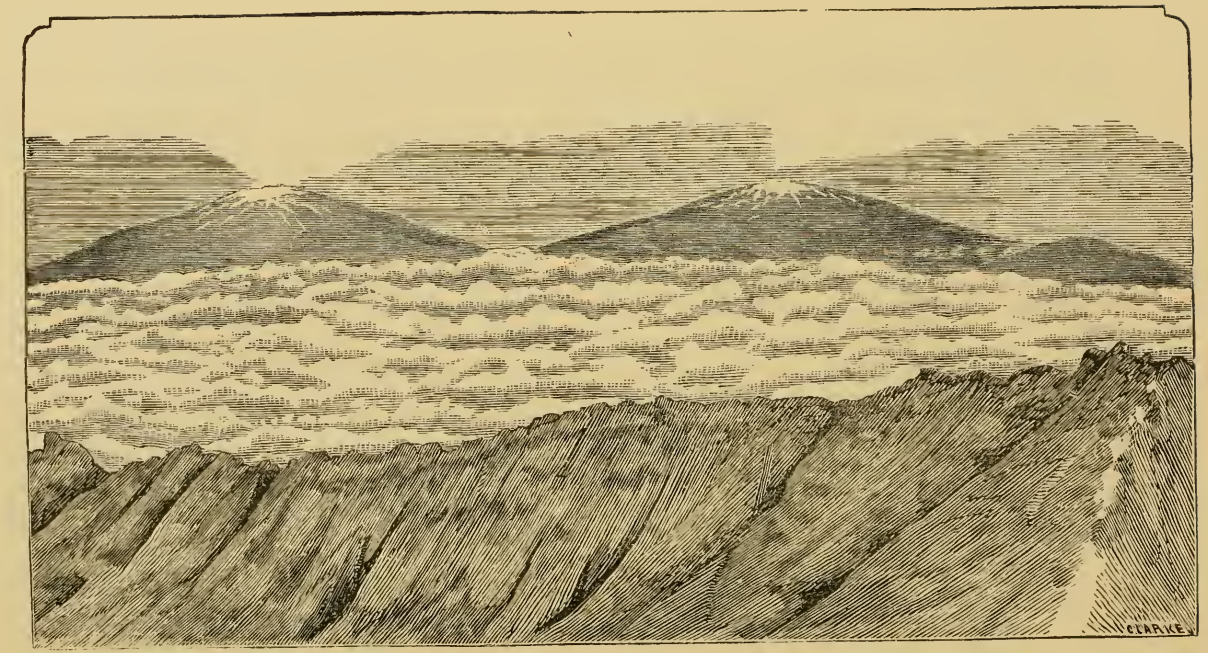
here, stretching below and before us, was a crater 27 miles in circumference and from 2,000 to 3,000 feet deep. A section of the Allegheny mountains from Cresson to Altoona, if inverted, point downward, would scarcely fill this yawning pit. The entire mountain of Vesuvius would not more than fill up this cavity. There is plenty of room for New York city within this crater—and I am not so sure but that a portion at least of it ought to be there.

In this immense crucible nature has, for countless ages, melted and poured out in rivers of liquid fire the contents of its capacious stomach to form the hills, rocks and valleys below. Here in this gigantic laboratory, Pluto has from time immemorial scorched, melted and sublimed (perhaps that explains why the scenery is so sublime here) material enough to make a continent. What a contrast, as it now lies a dead, silent mass of ashes and molten rock, after ages of belching and thundering that shook the very earth to its foundation!

There are thirteen cones in this crater. They are all respectable volcanoes in themselves, having well defined craters in their apices, from 200 to 600 feet in diameter. They vary in height from 300 to 800 feet, and from a quarter of a mile to a

mile in diameter at the base. Many of them would not suffer in comparison with Vesuvius. Here is an assortment of volcanoes that ought to suit the most exacting geologist—literally craters within a crater. The walls that compose this crater are for the most part perpendicular, and have a blackened, vitreous appearance from the intense heat to which they have been subjected. There are, however, several places whereby a descent can be made into the crater, but as it is the work of a day, we omitted this part of the programme, feeling more than satisfied with what we saw from the summit.

We passed the night under an over-arching rock, but even under the combined influences of a lively fire near us and plenty of blankets, we could not keep warm, so cold was it in the rarefied air of this lofty region. Sunrise came to find the crater entirely shut out by dense masses of clouds floating about midway from the bottom. The whole sky was undercast—that is the right word now—with clouds. In a few minutes the heat of the sun began to dispel, first the clouds in the crater, then along the mountain slope until they were scattered in straggling masses, so that the ocean, the valley, the earth below, so long eclipsed, were once more



A View Across the Clouds from Haleakala to Mauna Kea and Mauna Loa, 100 and 120 Miles Distant.

in view. This dissolving away of the clouds and the gradual reappearance of the world beneath us, is a spectacle the grandeur of which cannot be described, but once seen will never be forgotten.

We reached Mokawau on the next evening, there learning that the steamer would be at Ulapalakua the next morning on its way to the island of Hawaii, 100 miles distant. As we had seen inactive craters enough, we accordingly took the boat and set out to see a real, live volcano.

CHAPTER XIV.

Hilo and its Vicinity.

We arrived at Hilo, on the eastern shore of Hawaii, after a run of 30 hours. I don't know what Hilo means in English, but am certain I know what it ought to mean—rain, eternal rain. I never saw anything like it. If Noah's ark had drifted here instead of to Ararat, I am certain it would be afloat yet.

Instead of raining here forty days and forty nights, it pours down three hundred and sixty-six days in the year, and the rest of the time it is quite showery. It is currently reported that the inhabitants even dry their clothes in the rain; but for the truth of this latter statement I wish it distinctly understood that I do not vouch. On the contrary, I feel it my duty to advise that it be received with great caution, as it is probably an exaggeration.

I am informed by one who has kept a record for some years that the annual rain-fall here is over 22

feet, and even more than that a little way up the mountain. When I say that within twenty or thirty miles of this place, in several directions, the rain-fall does not amount to six inches per annum, some idea may be formed of the endless variety to be found in these curious islands.

Hilo is located on the eastern shore of Hawaii, at the base of Mauna Kea, whose summit, clad in eternal snow, is clearly visible in the distance, and to the right, as you approach the city; while Mauna Loa to the left, some 80 miles distant, springs up a smooth rounded dome, from whose apex rises a column of smoke, high above the summit, spreading out in a fan-like form, dissolving into the azure blue of the sky, and attesting the presence of volcanic fires within.

They call it a city here, but in our own country it would rank as the most modest of villages. However, as it is, *relatively* to the population of the islands, about half as large as New York, we will excuse the metropolitan airs its citizens put on. It contains about 500 inhabitants, of whom, as is the case with all the towns of the islands, a vastly preponderating proportion are natives. It is the only town of any importance on the island, and with the exception of Kailua, located at the northern

extremity of Kealekekua Bay, on the western side, is about the only port where any considerable traffic is carried on.

The little steamer Kilauea touches here once in two weeks (when the weather is fair) and one or two erratic schooners occasionally drop in, with something of the regularity and certainty with which a comet approaches the earth. The occurrence of this event is an occasion of real excitement, and forms a healthy variation in that monotony of life which is marked only by the daily routine of earthquakes or volcanic eruptions, which arouse some degree of mental activity and serve in a measure to dispel that dozing lethargy which fastens upon the mind in this dreamy climate.

By the scandal-loving native the vessel is hailed as a messenger with a well-filled budget of gossip, which has for weeks accumulated in the courtly atmosphere of Honolulu, or which has rippled the social surface in the more quiet and rural life of Maui. But by the solid man of business and letters it is looked upon as a herald of matters of weightier import; for he is aware that peradventure some steamer or clipper ship from Australia or California may have touched at Honolulu before the departure of the schooner. The fortunate con-

junction of these events he well knows will bring news *fresh* and startling from the great world abroad.

It is pleasant to see him drop eagerly into his easy chair, impatient with his *last* daily paper, and observe the smile of perfect contentment and joy that lights up his face when, glancing at the date, he discovers that the earth has only made 45 revolutions on its axis since, by the magic of the press, this waif was flung into the great ocean of news.

It is one of the quaint experiences of a sojourn in these islands to be carried literally over the space of three generations, and see with your own eyes how our worthy ancestors lived, moved and had their being in ante-telegraph and railroad times.

This means of communication forms the only connecting link between Hilo and the outside world. There is no harbor here, but a passable roadstead provides some degree of security for vessels when the weather is not too stormy. There are a few good buildings, and one or two churches of fair dimensions, over one of which Rev. Mr. Coan, the veteran missionary, presides.

The vicinity of Hilo abounds in objects of interest. About six miles toward the summit of Mauna

Loa is the terminus of the great lava flow of 1855, which was making straight for Hilo, and the doom of Sodom seemed to be upon it, when suddenly the eruption ceased, and the flow stopped short about six miles away, much to the relief of the terror-stricken inhabitants.

In going from the city into the pleasant district of Puna, the route leads through a forest of rare and wondrous beauty, beginning about three miles from Hilo. To say that the road—or rather path—passes *through* the forest, is strictly true, since for the distance of nearly eight miles the road is but a narrow tunnel cut through a matted mass of trees, ferns and vines, closely interwoven, impenetrable in density and gorgeous in their luxuriance of growth, fantastic shapes and coloring.

After a sweltering ride of several miles over the heat-concentrating surface of a naked lava field, one plunges into this shadowy retreat as into the delicious coolness of a bath in the limpid waters of the Wailuku, as over many a blackened precipice and through solitary gorges it rushes onward to the sea. So dense is this forest that the piercing rays of a vertical sun are unable to penetrate, save in occasional streaks and streams of light, which, darting in illuminating beams through the tangled

FOREST SCENE NEAR HILO.

foliage above, kindles into a thousand splendors the fairy scene about us.

Nor is there a charm for the eye alone; for hidden in the deep recesses, the intricate mazes of this forest, multitudes of birds of rare, sweet notes pour forth in delicious melody their entrancing strains, as if to render complete the enchantment by blending with the harmony of color and form the inspiring sweetness of melodious song.

When looking upon this almost phenomenal growth of vegetation, it is easy to realize what before was so difficult, viz.: that marvelous growth of vegetation which, in the carboniferous age, geological science implies as a necessity in the formation of coal beds. But here we see, right before us, a co-existent demonstration, not only of the possibility, but of the theory itself, as one can readily see that a few centuries of accumulated organic debris, such as is contained in this wondrous forest, would be quite sufficient for the formation of an average stratum of coal.

Of course, in the impenetrable depths of this dense forest, wild beasts, venomous reptiles and noxious insects of great size and ferocity find a secure retreat in immense multitudes. In this you are entirely mistaken. Nothing of the kind can be

found throughout the length and breadth of this or any other forest in the islands. Not a reptile of any variety, even to the harmless lizard.

These islands, it must be remembered, are curious in not only what they contain, but equally so in what they do *not* contain. One of the most remarkable features of the islands is the entire absence of all kinds of wild animals, birds of prey, or reptiles of any kind. There are no snakes, alligators, crocodiles, or even toads or frogs to be found on any of the islands. With the single exception of centipedes, there is nothing that crawls upon the ground or flies in the air that is an enemy to human life.

This sense of perfect security adds greatly to the enjoyment of the tourist; for it is indeed a comfort to feel that in prowling about in the tangled network of a deep, dense forest, you are in no danger of treading upon the tail of a serpent, rushing into the jaws of an alligator, or intruding upon the lair of some savage beast. Even in the farthest depths of the wildest forest to be found in any of the islands, you are as secure from this peril as in the friendly shade of your own garden.

It is true there are multitudes of great fat spiders, that spread their radiating forms pendent in

the air, like cart-wheels, but they are as harmless as the web they weave. Even the mosquito is here devoid of the pertinacity and ferocity that characterize his American congener. He lacks the impertinence of his American cousin, and has a charming suavity of manner, a modesty of deportment that is an unspeakable comfort of warm nights. He is here a well-bred insect, and always approaches you with extreme diffidence and caution, and invariably presents his bill with an apology. This greatly moderated blood-sucking propensity is perhaps due to the indolent influences of the climate, which here produces in all animate things a sort of dreamy languor.

Curious enough, even this insect is not indigenous to the islands, but was introduced here since their discovery. There are those who claim to know the precise date of their importation here, asserting that the germs of the insect were contained in the water used on board of a whale-ship, as they frequently visit the islands as a port of relay and supplies.

This marked deficiency of nature was sought to be remedied some years since by an act of the native parliament, an effort being made to introduce upon the islands some of the more harmless varie-

ties of snakes, frogs and other reptiles. In pursuance of this scheme, a vessel was dispatched to foreign countries, and actually returned to the harbor of Honolulu with a select assortment of vermin. The natives, however, arose *en masse*, boarded the vessel during the night, and in a very summary manner disposed of its hideous, wriggling cargo. It is fair to presume that they did so upon the idea that they already had quite enough immigrants from foreign countries.

This paucity in the natural history of the islands has an important bearing upon the theory of geographical distribution of animals, and is well worth the thoughtful consideration of the natural historian.

I shall always remember with delight the pleasures of an excursion we made to gather coral here. The water over which we passed was clear as crystal, so that the smallest objects could plainly be seen at the bottom, many fathoms deep. Masses of coral of all sizes and shapes were growing in thick profusion in snowy clumps and clusters all over the bottom. Fishes of all sizes and varieties, and rare beauty, disported in the waters beneath, giving to the whole the appearance of a gigantic aquarium. The Kanakas, who are all expert swim-

mers, dive to the bottom—sometimes 40 to 50 feet —and after a long absence suddenly rise to the surface, holding in each hand a most bewitching bunch of coral. We went to a spot where the water was of moderate depth, and gathered these beautiful ocean products until we were tired, and then took up our journey to Kilauea.

CHAPTER XV.

A Trip to the Crater of Kilauea.

Having made up our minds to include an ascent to the summit of Mauna Loa in our trip to Kilauea, we completed our outfit at Hilo for this expedition. As it involves a ride on horseback of some two hundred miles over the roughest roads in the world, and much exposure besides, it became needful to thoroughly prepare ourselves for the hardships and discomfort awaiting us. We therefore procured three horses for our own use, and three mules for the natives who were to accompany us, having added a special guide here for this trip. Three pack mules carried our tent, blankets, provisions and instruments.

We left Hilo for Kilauea at six in the morning. It is needless to say in the rain, for nothing short of a special providence brings a clear day here. Almost without intermission we journeyed in the rain the whole day until our arrival at the volcano house—hard by the crater—late in the evening.

The distance is said to be thirty miles, but I am sure if reduced to its equivalent on an average Ohio road it would not be less than one hundred miles. The volcano house is a small grass hut kept by a native, and provides accommodations for two or three persons, if not *too large* in their expectations. The weather being so unfavorable, of course we could see no signs of the crater until we were immediately upon it. The first evidence we saw was about a half mile from the volcano house.

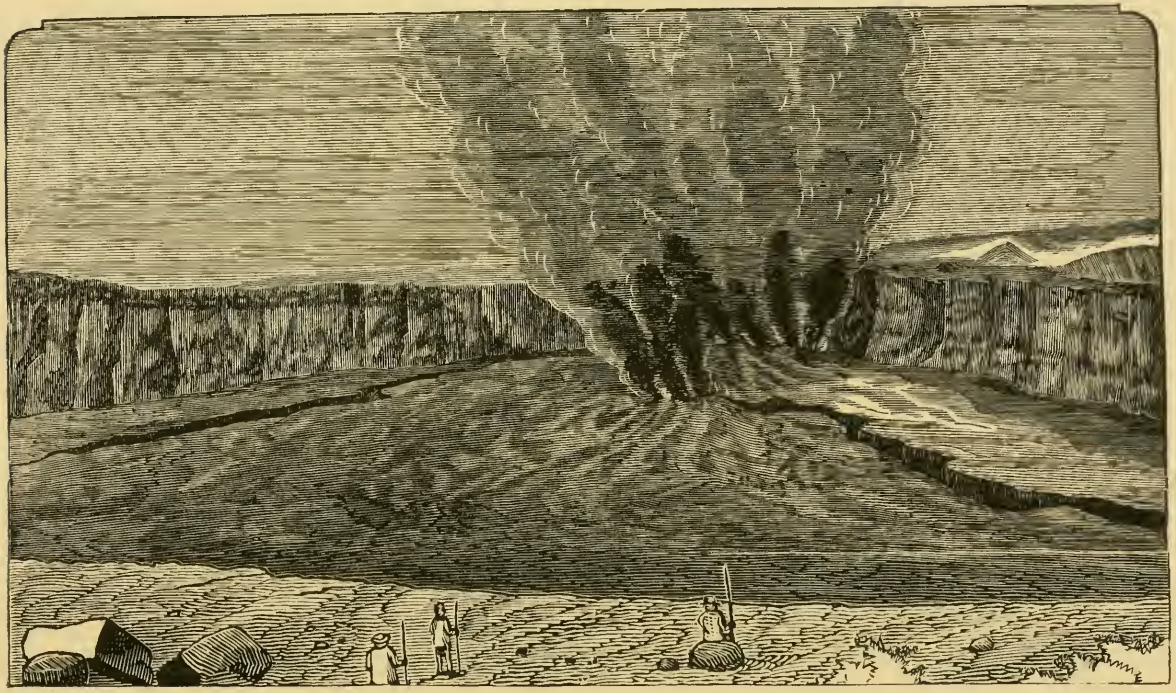
Jets of steam and smoke, laden with a disgusting odor of sulphur, were puffing out of fissures and pits in the earth all around, much resembling the smouldering fires beneath the surface of some immense lime kiln. As a dense fog hung over the crater, we could at first see no signs of fire, but as the clouds partially drifted away, the whole region became luminous with a lurid glare that looked like a distant city on fire, viewed through a dense cloud of smoke. The clouds of smoke, the rising steam jets on all hands, the strong smell of sulphur, the swashing sound of the invisible molten lava in the crater below, gave to the whole region an uncomfortable outlook of perdition.

Feeling literally used up by the day's journey, we retired at once after supper. During the night

I awoke and found our room brightly lighted up by the fires of the distant lake. The clouds had lifted, leaving the crater clear. The fires of the burning lake shone with dazzling brightness, tinting the whole heavens with its red, fiery blaze.

To those who are accustomed to look at pictures of Etna, Vesuvius or Stromboli, with their sharp peaks, and a puff of smoke wreathing their pointed summits, the crater of Kilauea will scarcely fill their idea of what a volcano should be. It is, however, celebrated for two things: as being the largest active crater in the world and as being the only one whereby a near approach can be effected to the burning lake when in an active state. Mauna Loa (long mountain,) upon the side of which Kilauea is situated, rises to a hight of over 14,000 feet, spanning the island from ocean to ocean.

Where the crater is located, 3,700 feet above the sea, the slope of the mountain is very gentle, being to the unpracticed eye perfectly level. It may, therefore, be truly defined as an immense hole in the ground and looks as though some day the whole face of the earth, the size of the crater, had suddenly fallen down a thousand feet or so, leaving a circular rim of perpendicular walls that bound the crater. This wall is now from 500 to 800 feet high.



GENERAL VIEW OF THE GREAT CRATER OF KILAUEA.

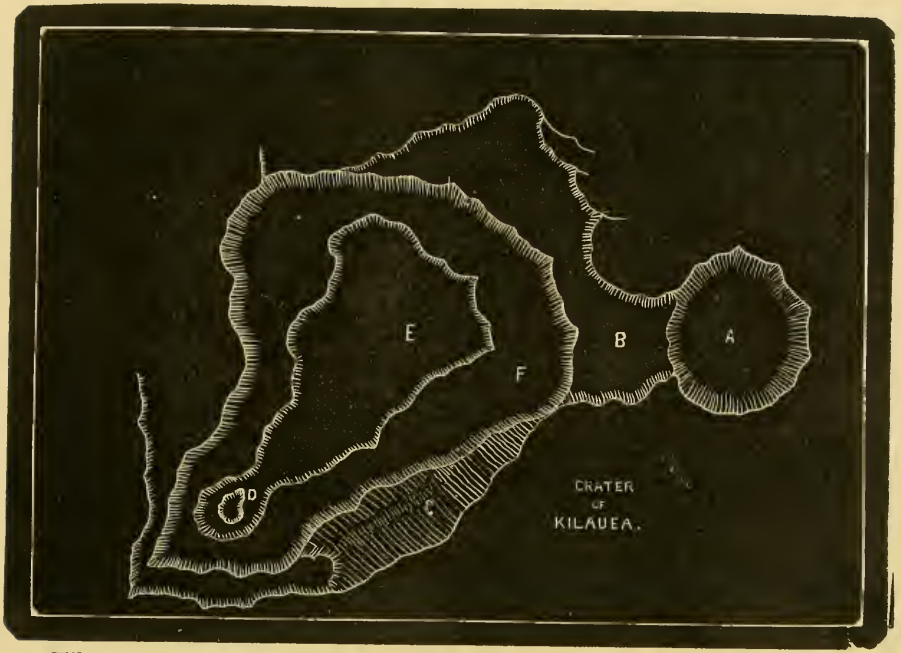
This brings you to a terrace or ledge that lies like a concentric ring a half mile wide at the bottom, and around the extreme edge of the basin. At the inner edge of the second ring or plateau, there is a second drop of 150 feet. This brings you to a sharp and defined basin about two miles in diameter, and of almost level surface.

The crater, therefore, as a "whole," may be described as consisting of a main basin, three miles in diameter, of an average depth of six hundred feet, in the bottom and center of which is another basin two miles in diameter, depressed about one hundred and fifty feet. The latter is in fact a real lake of fire, perhaps a thousand feet deep, and covered over with a comparatively thin incrustation of black hardened lava. The form of the crater may be better understood when I say that prior to 1868 the main crater, three miles in diameter, had filled with liquid lava to within five hundred feet of the verge. In the general wreck of matter during that year, when the whole island was tilted about with earthquakes, Kilauea no doubt "sprung a leak," causing a central mass full two miles in diameter to suddenly drop over eight hundred feet. The bottom literally fell out. Since that time this central basin has been filling up, and is

again within one hundred and fifty feet of the first bottom, constituting the ledge referred to.

At the eastern end of the interior basin there is a mound rising up to the hight of 150 feet above the general level of the bottom. It is about a half mile in diameter. On the summit of this mound is found the real live active lake. It is usually only one lake called Halemaumau (everlasting house) but sometimes divides into several. This is the central point of interest in the crater. It is here that the real outlet is found, where the flowing lava pours out to fill the vast area below. Taking our man Antonie and a guide from the volcano house, we set out to reach this lake. Providing ourselves with suitable clothing and a staff, we commenced our descent into the crater.

The descent of the outer wall is effected by an old rickety staircase of half decayed trunks of ferns, laid in parallel rows on the steep earth. The labor of a half hour brought us to the old bottom of 1868. Crossing a field of lava the black surface of which was twisted, wrinkled and distorted into a thousand curious shapes and figures, and which crackled under our feet and wore our boots in a ruinous manner, we at last reached the outer edge of the lower or central basin.



A, Kilauea Iki or Little Kilauea; B C, Terraces: D, Burning Lake; E, Main Basin; F, Black Ledge.

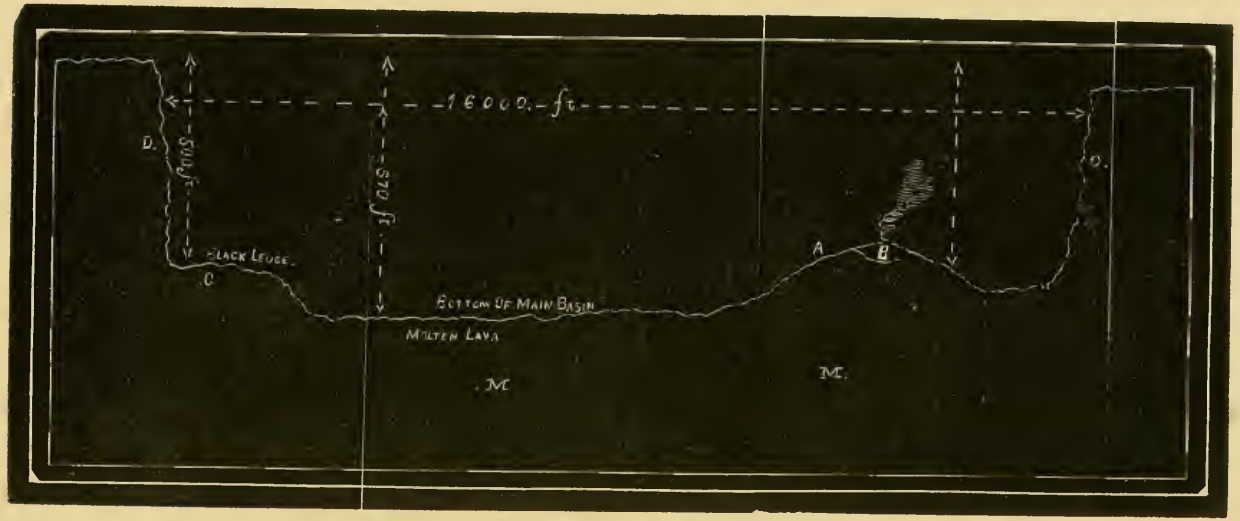
From here it is about a mile and a half to the burning lake, and our route lay directly across this fiery ocean. Our guide, after some hesitation, and a few minutes' careful inspection, ventured out upon it, and we followed. We had not advanced a hundred yards until I began to feel a burning sensation at the bottoms of my feet. Stooping down, I placed my hand upon the surface of the lava, and found it was almost burning hot.

We were indeed upon a literal sea of fire. This whole vast blackened surface was but a thin crust upon an abyss of molten lava hundreds of feet deep. As the lake for some days has been unusually active, it has poured out a stream of lava which has caused a sudden rise of some 50 feet in the pool below. This has heaved up the hardened surface, breaking it into huge cakes of lava, which are crowded and piled up in irregular masses, giving the whole surface the appearance of an ice-field after the sudden subsidence of a flood. The surface grew hotter and hotter as we advanced.

Through the innumerable cracks and fissures that lined the surface, we could see the glowing white molten lava beneath, upon which the thin crust on which we were standing almost seemed to float. We thrust the end of a staff a few inches

into a crevice, and it was kindled into a blaze in an instant. In many places, by a sudden contraction of the crust, the edges of the broken lava were thrust up so as to partially overlap other adjoining edges, plainly revealing their half-hardened, half-molten condition. The crust upon which we were walking I should judge was about two feet thick, one-half of which was cooled to a blackened state, and the other half fading by insensible degrees from a red into a white, glowing, melting heat.

It was a strange and terrible situation, thus to be standing upon a thin crust of half-congealed lava, which alone separated us from a depth of perhaps a thousand feet of molten rock, limpid as water. The occasional grating and grinding sound of the huge cakes as they contracted by the rapid cooling of their surface was not calculated to quiet one's nerves. I began to feel like I wanted to go home. We, however, pushed forward until a sudden change of wind drifted over us a current of blistering hot air, saturated with the strong fumes of sulphur. The wind having changed, its course was now driving towards us the parched air from the surface of a thousand acres of recently flowing lava, shimmering and quivering a half mile to the right of us.



SECTIONAL VIEW OF KILAUEA.

A, Lava Cone; B, Burning Lake; C, Black Ledge; D D, Perpendicular Wall of Crater; M M, Molten Lava.

A thousand feet or so of liquid fire beneath us we did not mind so long as it did not burn the soles of our boots off; but we did not care to take the chances of being smothered by the hot breath from "Pele's furnace," so we beat a hasty retreat. Our guide now informed us that if we wished to reach the lake, we would have to change our course and make a detour of some four or five miles—a tedious, exhausting walk. We set out on our new route, bound if possible to reach the lake, and not to be discouraged by ordinary impediments. As the Irishman said when he was trying to kiss Biddy, "*we were determined to get at the crater's mouth.*" We now cautiously threaded our way along the edge of the basin, it being more pleasant to our feet.

We suddenly discovered a stream of flowing lava that had burst out of the mass below and was winding in a long, red, blazing sheet over the blackened surface of colder lava. We cautiously approached it, and by keeping to windward could go within a few feet of it. Turning our faces to avoid the fierce, blistering heat, we plunged the end of our staff into the thick viscid mass, which adhered to the end in glowing, plastic lumps. It is very much like melted glass, being of a tough,

waxy nature, and can be moulded readily into any form while hot. It cools rapidly, however, becoming quite brittle when cold, and breaking with a clear lustrous fracture. We twisted it like wax into every grotesque shape, inserted coins about which it quickly hardened, securing in this manner many curious specimens. So intent were we on watching this new sight, that we did not discover, until our guide called to us, that another stream had burst out a few hundred feet away, and was rapidly circling about us, and if we did not quickly escape we would be imprisoned within an impassable circle of fire.

We did not wait for a second warning, but went. As we neared the active lake, our guides became more and more cautious, carefully sounding with their staffs the thin, hollow shells we were constantly crossing, being now upon a bed of lava that had only recently flowed over the lip of the lake. In a few minutes we were on the very verge of the fearful, seething, boiling cauldron. The awful sight that we beheld as we gazed into the fiery abyss at our feet struck us dumb and held us terror-stricken to the spot. For some minutes not a word was spoken, and I could read in the furtive glance from every eye, and in each pallid face, the

CROSSING A LAVA FIELD.

one common thought which this appalling scene suggested.

The sulphurous exhalations from the fiery brain of a Dante or a Pollock, or the black and white horrors that distil from the burning pencil of a Dore, will never again inspire me with a sense of terror. Pen or pencil can but feebly portray the terrific grandeur of this living, moving, surging sea of fire, as it lashed, and tossed, and hissed, and boiled, in all its crimson fury. Surely here was a lake large enough, bright enough, hot enough, sulphurous enough, and terrible enough, to suit the most exacting and devout follower of Calvin.

As near as I could judge the lake was about 700 feet in diameter. The usual distance from the edge of the lake down to the surface of the lava is about two hundred feet. As it has been quite active recently, it is now filled to within fifty feet of the top. It sometimes rises in an hour or two to such a degree that it pours over the edge of the lake, and then quickly subsides to its normal level. The whole contents of the lake was in a liquid state. There were numerous jets or fountains of lava playing in various parts, throwing the white liquid lava fifty to eighty feet in the air, with a loud puffing sound, as the pent-up air and steam

escaped. The walls around the lake are black, and glistened with a vitreous coating which has been formed by the lava, as it dashes against its rugged face like the surf of the ocean. The whole inside looks very much like the interior of a blast furnace after a heavy blast has been run. In many places the lava kept surging in great red billows against the perpendicular wall, which seemed to melt before it like wax.

On the opposite side from us, I noticed that an immense cavern, fully one hundred feet deep, had thus been literally melted out, in which the white hot lava surged and dashed about in the most furious manner, sometimes leaping to the very roof of this cavern, full forty feet high, dashing its fiery spray over the red hot dome from which it dripped and trickled continually in a thousand long, ropy streams. At times the fire would abate its fury for some minutes, when the lake would be quickly covered with a half-hardened stratum of lava. In an instant a stream of light would dart from shore to shore, then others in various directions, when suddenly, with a terrific explosion, huge cakes of lava would be hurled high into the air with an immense column of molten lava, the whole descending with a fearful splash, disappearing under the

surface and remelting in an instant. Rocks of the most obdurate nature, when thrown into this lava, melt like lead.

As the wind was favorable, the Professor and I advanced to within forty feet of the edge of the lake. As there was a jet in full blast near the side next to us, which threw particles full thirty feet above us, descending sometimes on the verge of the lake, we did not care to cultivate a closer acquaintance. Our position was directly between the two lakes, the southern one of which, some three hundred feet distant, we could not reach on account of a current of hot air. The lava upon which we stood was so hot that we could only keep our feet from burning by changing from one to the other. We were, in fact, standing upon the vaulted archway of an immense tunnel that connected the two lakes, and through which, right under our very feet, the liquid lava flowed and reflowed in eddies and waves.

How perilous was our position will be realized when I state that in a few days thereafter, a great portion of this very roof fell through into the fires below; and I noticed on our return to Kilauea a week after, that the whole dividing space was rapidly melting down, so that in all probability in a

few weeks the two lakes would again be enclosed in one continuous wall. How long we remained here I know not. No one in this terrible presence can take note of time. We returned to the Volcano House after an absence of nine hours, completely exhausted by the excitement and exertion of the trip.

After partaking with unusual zest of the supper which awaited our return, prepared by our generous host in his provident care for our comfort, we surrounded a cheerful, blazing fire—for it must be borne in mind that at this elevation, as the night approaches, cold, chilling blasts are sent down from the summit of Mauna Kea—and there reviewed the thrilling adventures of the day.

We soon, however, fell into a drowsy torpor, the uncertain sleep of exhaustion, from which we were suddenly aroused by the clamor and excitement of the natives, who were briskly hurrying about in wild disorder. On awakening, I found the room brilliantly lighted up, and the whole sky suffused with a ruddy tint, as though a great city were ablaze. Even the far distant summits of Mauna Loa and Mauna Kea reflected from their snowy surface the rays that pierced the darkness and gloom of night.

HALEMAUMAU, OR BURNING LAKE.

Rushing to the brink of the crater with our glasses, we there beheld a sight that was calculated to strike terror into the stoutest heart. The lake we had so recently quitted had suddenly sprung into a fierce, maddening activity, lashing its glowing surface, in a tumult of rage, into great whirls and billows of fire, throwing with violent explosions huge masses of red-hot stones, commingled with a shower of liquid lava, high into the air, and slopping over the brink of the lake in great currents the fiery contents of its capacious stomach, which poured in livid sheets of fire and gory streams over the very same spot where only a few hours before we had stood.

From some mysterious agency, the lake had suddenly filled to within a few feet of the surface. During a period of activity this intermittent rise and subsidence is always manifest, and it is surprising how quickly the lava will sometimes rise in the lake, even to a hight of 30 to 40 feet. When the Professor and myself made our near approach to it, we noticed that several times during our short stay the lava would rise, in the space of a few minutes, several feet, and then slowly subside to its usual level. This is caused, I presume, either by a sudden acceleration in the flow of lava from

its subterranean source, or by a temporary obstruction to the flow in the channel which serves as an outlet through which the lava is discharged from the lake into the great basin below.

The sudden rise on the night I refer to must have taken place within the space of twenty minutes, and in view of the fact that it occurred only a few hours after we had left, makes me shudder yet to think of the extreme peril into which the irresistible fascinations of this wonderful phenomenon drew us.

Some definite idea of the immense volume of lava that discharges from this lake may be formed when the diameter of lake and hight of rise is considered. The quantity represented by this rise in the lake could not have been much short of 15,000,000 cubic feet. Yet large as is this quantity, it becomes relatively insignificant when compared with that which accumulates in the central basin during a few days of activity. As before stated, the diameter of this basin, encompassed by the inner verge of the black ledge, is fully two miles. Yet during our stay at Kilauea, the surface of this basin had risen about fifty feet, which would indicate that over *twenty-seven hundred millions* of cubic feet of molten lava had flowed into it during that

time, or over 225 millions of tons—more than all the blast furnaces in the United States combined could melt in eighty years, even if it were no more refractory in its nature than iron.

We watched this terrific scene until late at night, and when we were at last obliged by sheer fatigue to retire, the scene was one of unabated terror and grandeur, and the lake shone with undiminished brilliancy.

The next morning the lava had receded in the lake to its normal level, but the dense volumes of smoke, and the still glowing surface of incandescent lava spreading over the sides of the cone, bore evidence of the mighty throes that had so recently raged in its fiery bosom.

Mounting our horses, we rode several miles along the western brink of the crater, until we arrived at a commanding point, where we could look down upon the surface of the lake, now something over a mile distant. From this hight we could obtain a fine view of the lake, which, though distant, was in a measure compensated by the comforting thought that we were not in momentary danger of being plunged into the fiery embrace of death—a fate one certainly tempts by venturing near its treacherous brink. Yet even this point of observa-

tion is not devoid of danger, as we stood upon a crumbling wall of congealed lava nearly 1,000 feet in perpendicular hight.

Of the terror that fills one in looking down into this blackened abyss, the Rev. Mr. Cheever says: "One of the early visitors there said that on coming near the rim he fell upon his hands and knees awe-struck, and crept cautiously to the rocky brink, unwilling at once to walk up to the giddy verge and look down as from a mast-head upon the fiery gulf at his feet." He further says: "I have myself known seamen that had faced unfearingly all the perils of the deep and had rushed boldly into battle with its mammoth monsters, to stand appalled on the brink of Kilauea, and depart without daring to try its abyss."

It may be regarded as a fortunate co-incidence that the trade winds here perpetually sweep in a strong current in the direction of the only possible approach to the burning lake. It is to this circumstance alone that a visit to the lake becomes at all possible, and it explains what may seem so unaccountable, that the fierce heat, radiating from such a large expanse of liquid hot surface, does not prevent a close approach to it. Were there that variability in wind currents at Kilauea that exists in

other countries, no one could safely venture near the brink of Halemaumau, as the sudden shifting of the wind might drive over the unfortunate spectator a blast of air fervent with heat from the seething surface of lava, which would instantly parch him into a crisp. Were it not for this stability of the wind, even a nearer approach than the black ledge would be impossible, since even at that distance, though the heat might be moderated within endurable limits, yet one would be certain to be stifled by the strong fumes of sulphur with which the air is constantly laden.

Although there is a stiff breeze blowing from you without a moment's intermission, even then, when in close proximity to the lake, one can scarcely avoid the blistering effects of the fierce radiant heat, and it is only by keeping the face averted and by occasionally dropping under the friendly lee of some projecting piece of lava that you can maintain your position for any length of time.

Kilauea or Lua Pele (Pele's pit) as it is termed by the natives, is in the native mythology the abode of that most terrible of the volcanic deities "the goddess Pele." Here, reveling in the fetid fumes of a noxious atmosphere, and disporting in the fiery surf of the great red billows that dash

their livid crests against the blackened walls of the crater, the goddess and her attendant spirits hold their horrid nightly vigils.

It is no wonder that a race of people by nature superstitious, in the presence of so great a mystery, such awe-inspiring manifestations of force, should regard it as purely the effects of a personal agency, and it is natural that an imagination distorted by fear should find in the spectral shadows of a sulphurous air and the infinite shapes in the surge and surf of a fiery ocean, the ready material to be wrought by a morbid fancy into forms and shapes, the tangible personification of a power hidden in its source, and with effects so vast and terrible. I must confess that even with all the philosophy I could bring to bear I could not wholly repress a nascent pantheism, and in an imagination quickened by the evidence of life and power about us, I could almost discern the shadowy outlines of the spirits and demons that rule and people this realm of eternal flame.

I felt quite prepared to pardon the superstitious terror in which the natives hold this region, for they certainly do have a most wholesome dread of this pit, and never approach it without some act or token whereby to appease and conciliate the terri-

ble goddess. In former times, it was customary for the natives, as a religious rite, to throw infants into this lake of fire; and even now when they can summon courage to go near enough, they are certain to take something to offer as a sacrifice—most generally a twig or leaf of the sacred Maile, which they throw into the flames.

They are however very loth to approach closely to the verge of the lake. Even our own guides, after advancing to within a few hundred feet, refused to go farther, so that the Professor and myself were obliged to complete the remaining distance alone. My wife, with a courage and determination I can not too highly praise, resolutely accompanied us to within a short distance of the rim of the lake; but one glance at its fires was enough to dissolve her hitherto well-preserved courage, and the natives were glad enough to avail themselves of the opportunity to pilot her to a more comfortable if not a safer distance, leaving the Professor and myself alone.

This crater was first visited by the Rev. Mr. Ellis in 1823, or at least he is to be accredited with the first description of a journey to it. From his description of it at that time, while possessing the same general characteristics as now, it was as to

many points of detail quite dissimilar. In addition to the present south lake, the whole northern part was one vast flood of burning matter, that portion being now covered by the black ledge, and exhibiting no evidence of fire, save that which flows from the south lake.

There were at that time, also, fifty-one conical islands of various sizes and hights, rising from the burning surface. There are none of these now. This changeability is readily accounted for when the general mode of its activity is understood.

Kilauea, unlike all other craters, never overflows, but when filled to a certain point bursts a passage through the side of the mountain below the level of the crater, through which it discharges its liquid contents in devastating floods over the ill-fated country below. When this happens, the bottom of the crater drops down several hundred feet, where it remains until the eruptive flood ceases, when it again gradually fills up. This usually takes from eight to ten years, when the same emptying process is repeated. It does not, however, always burst a passage above sea-level, but quite as often finds a sub-marine outlet.

The first authenticated eruption occurred in 1789, when the whole island was swayed with ter-

rific violence by earthquakes, and great volumes of scoria, stones and cinders were ejected from the crater, that darkened the whole heavens. Another outbreak occurred in 1823. The earth, on this occasion, was rent in several large fissures, through which the lava, by the superincumbent pressure in the crater, spewed up in immense columns like an illuminated fountain, several hundred feet into the air, and descending, spread over a large tract of country in the District of Kau, finally reaching the sea some twenty-five miles distant. This stream of lava, before it reached the sea, is said to have been from five to eight miles in width.

There has been no outbreak since 1868, when the flow undoubtedly passed off under the sea level. The lava has now, as I ascertained by measurement, again risen (June, 1874) to within 120 feet of the level of the black ledge, and as it is very rapidly filling at the present time, it will soon again reach that level at which an outbreak is certain to occur. Near the northeastern side and connecting by a channel, is a small crater (now extinct) called Kilauea Iki, or Little Kilauea.

CHAPTER XVI.

The Eruptions of Mauna Loa.

Although all the islands of this group are wholly of volcanic origin, and are pitted all over with craters and deep fissures, and covered with great streams of lava, yet to the island of Hawaii is confined exclusively present volcanic activity. Neither by history or tradition are we able to fix the time when even the great crater of Haleakala on Maui, apparently so recently in an eruptive state, was in an active condition.

What is a little singular, and may become of value as a datum in dynamic geology—and may greatly aid in solving the perplexing problem of the origin of volcanic phenomena—is that the direction of increasing activity is from the northern to the southern end of the group. It is said upon the authority of careful observers that even the great earthquake waves that sweep through the islands follow the same general direction. Why this should be so, scientific inquiry has as yet dis-

closed no good reason; yet certain it is, and is a fact apparent to the most careless observer, that in progressing southward from the island of Kauai to the island of Hawaii, the evidence of more recent action becomes successively more and more apparent as we pass from one island to another, the varying ages of the several islands being thus shown to be almost in the inverse order of their distance from the most northern of the cluster.

Not only is volcanic action at this time confined to the island of Hawaii alone, but it is subject to the further limitation of being confined to Mauna Loa, the most southern of the mountains on this island. The island might be fitly called a tri-mountain island, as it is completely made up of the three mountains Mauna Loa, Mauna Kea, and Mauna Hualalai. Mauna Kea, the most northern, has never been known to be in an active state, and from Mauna Hualalai one eruption only—that in the year 1801—is known to have occurred, which is said to have been of the most terrific and desolating character. This seems to have been an exhaustive effort of its internal fires, as ever since the mountain has been in a quiescent state.

But it is from the terminal crater Mokuaweoweo, on the summit of Mauna Loa, and Kilauea as a

sort of side-show on the flank of this great mountain, that have sprung the grandest and most imposing spectacles ever witnessed by man. I have referred already to a few of the eruptions of the latter crater, and will speak briefly of some of the more notable of the former. The lava in the summit crater, like Kilauea, does not rise to the verge or rim of the crater and thus overflow, but finds escape by bursting the side of the mountain at varying hights above the sea. When this occurs, as it often does, at great depths below the summit, the pressure of the lava as it is ejected from the discharge orifice in the mountain side, forces out the confined mass with the greatest impetuosity, causing it to rush in torrents and cataracts of fire, with swift and certain devastation, over the country below, until it discharges into the ocean.

In 1843 an outbreak occurred at some distance below the summit, and the lava flowed down the northern slope in two separate streams, one westward in the direction of Kona, and the other eastward toward the base of Mauna Kea. This stream again subdivided, one branch flowing towards Hilo and reaching to the distance of thirty miles from point of outflow. In 1855 another outbreak took place, a stream of unusual volume and velocity

flowing to the distance of more than sixty miles.

Of this eruption the Rev. T. Coan says: "We were astir early on Saturday morning, climbing over indescribable hills, cones and ridges, masses of hot and smoking *debris* and scoria, scattered wild and wide over these Plutonic regions. We soon came to a line of jagged cones with open orifices of from 20 to 100 feet diameter, standing over the molten river and furnishing vents for its steam and gases. We approached the vents with awe, and looked down their fiery throats. We heard the infernal surgings and saw the mad rushing of the molten stream, fused to a white heat. The angle of descent was from 3° to 25°, and we judged the velocity to be forty miles an hour. The maddening stream seemed to hurry along as if on a swift commission from the Eternal to execute a work of wrath and desolation on the realms below."

Some idea of the quantity of lava poured out during this eruption may be formed when it is stated that the stream was over 60 miles in length and spread out over a surface of over 300 square miles, or one-thirteenth of the whole area of the island.

During the winter of 1859 occurred what in many respects was the most memorable eruption of this

mountain hitherto witnessed by civilized men. As was the case in all former eruptions, the side of the mountain was split open by the pressure of the lava, and as it occurred at a greater distance below the summit than any other eruption before, the lava therefore flowing out of the fissure with an impetus due to the pressure of a higher column of lava within the mountain, the grandeur, terror and magnificence of the eruption much surpassed any that had previously taken place. The outburst of the flow in 1855 was at a hight of over 12,000 feet above the sea. That of the year 1859 was some 4,000 feet lower down. It occurred on the northern slope of the mountain, and some ten miles from where the previous one had broken out.

The lava on this occasion, as we are told by those who witnessed it, was projected upwards in glowing red columns or fountains to hights varying from 200 to 500 feet. Huge blocks of stone, hundreds of tons in weight, would be torn from the ragged edges of the fissure and carried, like a cork in a miniature fountain, upwards with the hissing stream of fused lava, and falling on the sloping sides of the mountain, would roll with irresistible force into the forests and ravines below.

The lava stream, where it burst from the moun-

tain's side, was scarcely ⅛ of a mile in width, but as it discharged with amazing velocity, the quantity was so great that when the velocity became reduced, at some miles distance from the mouth of the fissure, it spread out in a flowing stream four to six miles in width. It swept along in its consuming wrath, melting rocks and devouring forests before it, until it reached the sea at a little fishing village called Wainanalai—full forty miles from the outbreak—where it plunged in its wild fury into the ocean.

The conflict that raged between the two battling elements as they swiftly closed in deadly strife, it is said was one of the most appalling character. As the flow rushed down upon the village during the night the natives had barely time to escape its devouring jaws as it came sweeping on, swallowing up everything in its path. It is said that when the hot lava dashed into the ocean, the reports of the suddenly expanding vapor were like discharges of artillery, scattering the foaming water and bursting fragments of lava everywhere in the wildest disorder. These explosions were heard to the distance of twenty-five miles.

The whole village became a prey to the devouring element, and the harbor was filled up with

lava as it crowded in successively overlapping folds farther and farther into the ocean. The Rev. Mr. Lyon, who witnessed this conflict of antagonistic elements, says: "For three successive weeks the volcano disgorged in uninterrupted burning streams, with scarcely any diminution, into the ocean. On either side, for twenty miles, the sea became heated, and with such rapidity that on the second day of the junction fishes came ashore dead in great numbers at Keau, fifteen miles distant. Six weeks later, at the base of the hills, the water continued scalding hot, and sent forth steam at every wash of the wave."

The last eruption of this volcano was in 1868. This occurred on the southern slope of the mountain, some ten or fifteen miles around the mountain from Kappapala. The precise hight above the sea where the mountain was rent asunder has not been ascertained, but can be but little over 4,000 feet, being thus at a much lower altitude than any that has sprung *directly* from the bowels of the fire mountain. The orifice opened during the eruption was small, and can yet be distinctly seen, being some thirty or forty feet wide, and a few hundred feet long. But when we remember that there was a column of liquid lava nearly two miles high

MAP SHOWING ERUPTIONS OF MAUNA LOA.

forcing out of this vent, one will not marvel at its incredible volume as it swept onward with irresistible impetuosity, a vast burning tide, into the ocean.

The hight to which the lava was thrown in blazing jets was greater than before, reaching over 600 feet in hight. As this flow was at such a low level, it was of course near the sea, and therefore but little damage was done, it having paled its ineffectual fires in the vain effort to boil down the waters of the Pacific. During the whole period of time covered by this eruption, the continuous mutterings of earthquakes gave forth a dull, dismal sound, and the whole island was kept in an incessant state of tremor and vibration. It is said that in one day there were over 300 distinct shocks of earthquakes felt in the district of Kau.

Simultaneous with this outbreak, Kilauea delivered the contents of its troubled stomach, the central basin emptying out to the depth of several hundred feet, but where it went to no one can tell, as it passed off beneath the surface, finding no doubt a subterranean outlet.

Taking these eruptions collectively, the probable inference is that Mauna Loa is a mere hollow cone, encompassing a cauldron of liquid matter, the

thickness of the sides varying with the degree of heat and other modifying circumstances. It is no doubt true that the greater portion of the internal space of the mountain is in a perpetual state of liquidity; and as it accumulates, rising higher and higher in the central perpendicular shaft, the terminal outlet of which forms the summit crater, the pressure upon the enclosing crust of the mountain becomes greater and greater, and at the same time by increasing volume and intensity of heat it becomes thinner and weaker, until by these combined causes an outlet is forced at the weakest point, or in the direction of least resistance.

There is another peculiarity about this mountain as respects the hardened lava which forms, so to say, its outer shell, which has an important significance touching a matter of which I will presently speak. Instead of being of solid character as its surface indicates, it is filled with an intricate ramification of tunnels, and huge blubbers of all lengths and sizes. So intimately do these enter into its very structure that in walking over its surface you can almost everywhere hear a sort of hollow drumming sound, the reverberation of the sound in the cavities beneath you.

These tunnels or channels are at various depths

below the surface, and covered with crusts varying in thickness from a few inches only to several feet. In passing over an apparently solid surface, you not unfrequently break through with an unpleasant suddenness into one of these small tunnels a foot or so in depth. Great numbers are to be found where the surface has broken through in great dark holes, through which you can look down into the cavernous depths of the earth, sometimes to the distance of 80 to 100 feet.

Some of these channels extend for miles, and have been explored to that distance without finding a terminus. They all bear evident traces of having once formed conduits for molten lava, as the interior surface has a glazed, melted appearance, and innumerable stalactites of congealed lava hang pendent like icicles from the roofs.

Take it all in all, this mountain does not offer specially attractive inducements to investors in real estate, as between its earthquakes, eruptions, and treacherous bottom, its permanence and security as an investment are rendered somewhat questionable. If luckily you should find that the usual nightly earthquake had left your farm right side up, or that it had not been irrigated by some eruption with a few feet of watery lava, you may

count upon it as a moral certainty that the third calamity has overtaken you, and you will discover that your real estate has suffered a decline, has dropped, fallen at a ruinous rate, fallen in fact to the bottom of the Pacific Ocean!

There is one peculiarity growing out of the relation of the crater of Kilauea to the summit crater, over which the resident scientists of the islands, as well as savants generally, have been greatly perplexed for a satisfactory explanation, and which has given rise to various theories touching their action, as being either separate or co-operative. As before stated, the crater of Kilauea, unlike all others, is not formed by the terminal cavity in the apex of a volcanic cone, but is located on the eastern slope, or rather near the base of Mauna Loa, the gently sweeping curve of which at this point is scarcely to be distinguished from a level tract of land.

I found by barometric measurement that the crater is located at a hight of 3,800 feet above the ocean. It has long been a matter of much speculation whether this crater and the crater of Mokuaweoweo on the summit be separate and independent, or whether there is between them a correlated action. While the former hypothesis is rendered

untenable by the physical characteristics of the mountain itself and the island as a whole, as well as by other reasons not now necessary to point out, the latter can scarcely be maintained upon grounds that can be made to harmonize with the known laws of physical forces.

If the conduits through which the lava flows into each crater be connected, either in the body of the mountain itself, or at a greater depth and below the level of Kilauea, why does the liquid lava rise in the central shaft or channel to a higher level than the point of exit of the conduit that discharges into Kilauea? Or as an hydraulic effect more familiar, why does not the fluid contents of the mountain pour out through the opening in the lower crater? If the two conduits are joined together, or rather are the common effluents of one larger channel rising into the base of the mountain, the amount of unbalanced pressure resulting from the difference in hight of the conduit leading to the summit crater over that leading to Kilauea becomes enormous.

As the summit crater is nearly 14,000 feet above the sea, and is usually filled to within 600 feet of the verge, and as the bottom of Kilauea is only 3,200 feet above the same level, it follows that the

pressure due to gravity at the point where the conduits join is for the axial channel an amount in excess of that leading into Kilauea, by so much as would result from a column of fluid lava nearly two miles high. As the specific gravity of molten lava—water taken as unity—is about 2.4, this pressure would be something over 12,000 pounds to the square inch.

Is it not somewhat remarkable, if there be a union of the two channels, that under such an amazing pressure the lava is not ejected from Kilauea with a prodigious force; and would not this flow continue until the whole contents of the mountain was emptied down so that the lava would stand at the same level, or nearly so, in both the tubes? This must be so, or else this substance forms an exception to the general laws governing fluids in motion.

But in explanation of this singular phenomenon, Prof. Dana and others say that the point where the conduits unite may be at such an immense depth as to reduce this difference in hight to relatively an insignificant amount.

Let us see how much of value there is in this explanation, and for how much it can be made to satisfactorily account. In the utter absence of all

evidence that there exists any difference in the dimensions of the respective conduits, it is fair to presume that they are, relatively to the quantity of lava transmitted by each, of the same capacity. Any difference of pressure, therefore, necessary to force the lava through the veins that may exist in the columns at any given hight, is referable solely to the difference in friction by reason of one channel being of greater length than the other. It is certainly an evident truth that under these conditions the force that propels the lava through one channel would force it to the same distance in the other also, leaving the hydrostatic pressure as completely unbalanced as though the tubes were relatively short.

Assuming therefore, what is highly probable, that the central or axial conduit is the perpendicular or most direct, and that leading into Kilauea is merely an offshoot or lateral branch, it follows that the difference in pressure, at the point of discharge in Kilauea and in the central shaft at the same level above the sea, is due solely to the retardation in flow of lava resulting from the excess in length of the former over the latter. That difference to be attributed as a consequence to variation in form or degree of sinuosity need not here be considered,

as the check to the flow in either from this cause would be comparatively so small as to make this an element of but little import.

The distance in a direct horizontal line from the crater of Kilauea to the axis of the mountain can not be greater than twenty miles. Let us assume for the purpose of illustration that the point where junction of the two conduits occurs is at a perpendicular depth below the level of Kilauea equal to the horizontal distance from Kilauea to the center of the mountain, as under this assumption the greatest possible difference in length will be produced—it being a familiar geometrical truth that the greater the ratio of the perpendicular to the base, the less becomes that of the base to the hypothenuse.

Under this hypothesis, we would get for the conduit supplying Kilauea a length five miles greater than that which supplies the summit crater. We are therefore driven to conclude that this vast superincumbent pressure of over 12,000 pounds per square inch, represented by the difference in the perpendicular hight of the two columns, is all consumed in overcoming the friction in 5 miles of volcanic tube necessary to impart that velocity with which the lava passes into the crater of Kilauea.

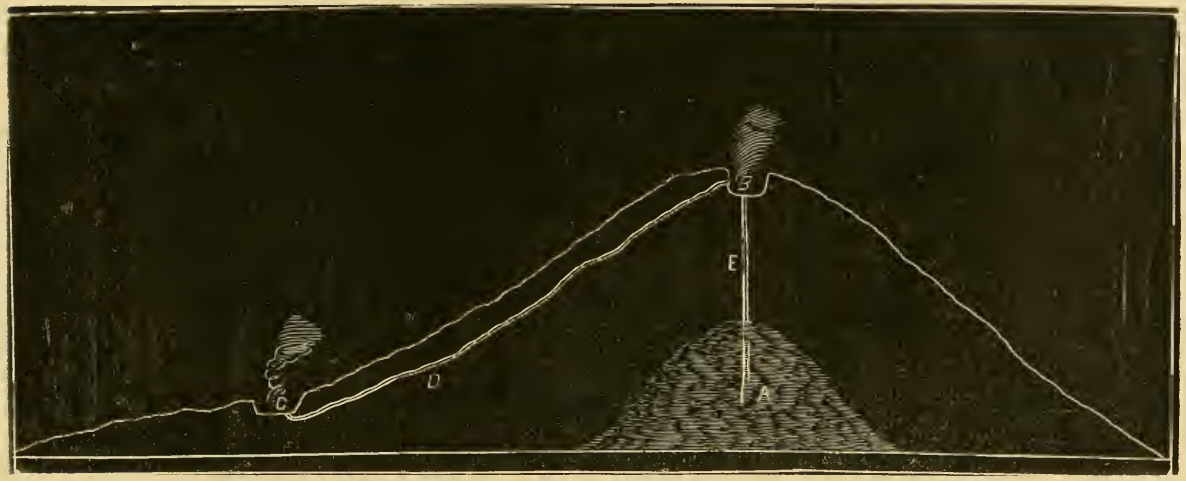
Let us determine what this velocity may be, in order to at least proximately apply those laws of hydraulics from which in other flowing liquids we are enabled to deduce precise and accurate data. As the recurrent periods of eruption average about ten years for Kilauea, and as the quantity that flows out each time is that which is contained in a space about two miles in diameter and from 400 to 500 feet in depth, it follows that there is 25,000,000,000 cubic feet discharged into the crater during the lapse of ten years. This will give very near 80 cubic feet per second as a continuous uninterrupted flow. The average area of cross-section of the large number of tunnels I have observed would not be much less than fifty square feet, many of them far greater and few less. Assuming that the conduit in question was only six feet in diameter, this would give a velocity of only about three feet per second.

Now the formula $d=\left(\frac{g^2xL}{v}\right)^{\frac{1}{5}} \div 3$, when applied to determine the amount of pressure necessary to overcome the friction of water flowing through pipes, would give, for the values in the present case d and v, as the requisite pressure about 330 pounds per square inch, corresponding to a hight of 760 feet. Allowing for the greater density and

somewhat less mobility of molten lava, a hight of 1500 feet would certainly be quite ample. This would leave a column of more than 9000 feet in hight, the pressure of which would be brought directly to bear and wholly utilized to eject the lava from the mouth of the conduit opening into Kilauea.

Deducing from the same formula (with the corrections allowed for density &c.) a value in terms of area in cross section of channel, we find that a tube of four square feet transverse area would be quite sufficient to pass the quantity given under the pressure that actually exists. This small area cannot be regarded as consistent with the fact that, for centuries perhaps, the enclosing walls of this lava tunnel served to conduct a liquid that reduces solid rock like wax, and yet did not become enlarged to a material degree.

That a violent ejectment of lava should result from the great pressure of the central column is abundantly proven by the eruption of 1868, on which occasion it was forced in perpendicular columns hundreds of feet in the air; and this, too, occurred at a point quite as remote as Kilauea from the geometrical center of Mauna Loa. In explanation of this mystery, and in accordance, I



PROBABLE CONDUIT FROM MAUNA LOA TO KILAUEA.

believe, with observed facts, I would suggest that instead of a communication between the two craters existing below the level of Kilauea, the point of communication lies near the summit of Mauna Loa, and that instead of a small channel in which the lava is confined under pressure throughout its entire length, it is similar to those everywhere to be met with on the mountain, which are of a size so large that only a small part of the area would be filled.

The lava thus flowing out of the side of the summit crater into a tunnel much larger than would be required to carry it, were it forced through by pressure, would therefore flow down by its gravity simply, in a stream similar to that which flows over the surface during an eruption. Descending to near the lower crater, it would accumulate in a pool, which would according to existing conditions and circumstances acquire more or less head, forcing it into the crater under a greater or less pressure, according as the lava may have accumulated in the tunnel above. This would account for the intermittent activity so curiously displayed by the crater, which can scarcely be explained upon the hypothesis of a connection with the axial channel at a level below its own crater.

It is a characteristic of the mode of its activity fully made familiar by observation that it is extremely irregular, remaining at times for days and weeks together in an almost quiescent state, when the flow of lava into the crater is almost imperceptible in amount; and then again, suddenly—as in the case we were so fortunate as to witness—millions of tons are poured out in the space of a few hours. This extreme variability in quantity of discharge I conceive to be wholly irreconcilable with the flow of a liquid (however viscid) through any form or size of duct, under a pressure of over 12,000 pounds to the square inch.

It however becomes a perfectly natural result, and consistent with the facts shown by observation under the assumption of a supplementary tunnel, extending, at some distance below the surface, upwards along the slope of the mountain, and entering into the cavity in the terminal crater near the summit.

The lava so flowing down in a regular stream might accumulate in an enlarged cavity at or near Kilauea for days or even weeks—checked in its final exit into the crater until a sufficient pressure would be produced to force a passage, when the whole mass would suddenly discharge into the

lake and thence into the main basin.

If a channel of communication really existed below the level of Kilauea, and of a size so diminutive as pointed out, would it not be a most natural result that the passage would quickly become greatly enlarged by the continuous transmission, year by year, of millions of tons of fluid lava, heated to the fiercest intensity? Under a pressure so great, the flow would be of the most regular character instead of irregular, as is really the case, since it is incredible that any possible obstruction could interpose, more than a momentary check, to the flow of lava propelled by so great an initial pressure.

This continuous flow of liquid substance, fervid in the freshness of its heat from the earth's great central furnace, would by degrees melt away the enclosing walls, enlarging by rapid increments the channel, so that the whole efflux of matter would take place at the lower crater, as fluids do not seek the highest but lowest level as points of discharge.

But the theory of action here presented rests not merely upon assumption, but receives strong confirmation in the facts revealed during many of the eruptions of both Kilauea and the summit crater. The Rev. Mr. Coan, a most careful observer,

and more familiar, perhaps, with volcanic phenomena than any one on these islands, speaks of a peculiarity he observed in one eruption witnessed by him. The stream of lava which on this occasion burst from the side of the mountain near the summit, flowed down the mountain in a great river for several thousand feet in the usual manner, when it suddenly disembouged into a tunnel, entirely disappearing, and flowed in an underground current, *where* no one knew, as it did not reappeár above the surface, finding in all probability a final exit under the surface of the sea.

During the eruption of Kilauea in 1868, when the lava was emptied out several hundred feet, the openings of several tunnels were revealed, which before the eruption were below the surface of the lava in the crater, and through which it flowed out at that time. There is no doubt that there is also a continuous flow of lava from Kilauea through subterraneous channels. This may explain the origin of a long line of steam and gas jets that can be seen extending many miles eastward to the ocean, bearing strong evidence of fires below.

But the ready objection to the theory here presented, and one at once suggested by Prof. Dana, in conversation with him, is that the existence of

such a channel would cause a reduction in the strength of the mountain's crust, making the direction of the tunnel the line of least strength also, so that the eruptions of Mauna Loa would always be in the direction of least resistance, or that traversed by the tunnel.

This objection is readily disposed of when we consider what a small part, relatively, of the solid crust would be occupied by the vacant space of a channel which would be of abundant size to convey the quantity of lava which daily flows into Kilauea. This quantity, we have shown, is an average of about 80 cubic feet per second. Allowing the very moderate velocity of ten feet per second for the rate at which the lava would descend of its own gravity down a steep declivity, this would give only eight square feet transverse area in a tube of sufficient capacity to carry the quantity named. Therefore a tunnel only ten feet in diameter would give over nine times the necessary capacity to transmit that quantity. In contrasting this small size with the thousands of feet of probable thickness in the shell of the mountain, it will be seen that the supposed reduction of strength becomes infinitesimal in degree, and may be more than counterbalanced in its effects in

other parts of the mountain by causes which may operate to produce greater local reduction of strength.

CHAPTER XVII.

The Origin of Volcanic Heat.

From contemplating the evidences, the wondering mind naturally and inquiringly turns in eager search for the causes by which effects so vast and marvelous are produced. Whence all this heat—a heat no less wonderful in intensity than in quantity? What is its source, and by what agency is it generated? Such have been the inquiries addressed not only to the mind of the scientific investigator, but to the simple child of nature, for ages. Happily, the fast spreading boundaries of cosmic knowledge, which successively includes in the circling sweep of its expanding waves larger and more general truths, has at last enabled us to satisfactorily answer these questions.

Although the real source of the heat displayed by volcanic action is settled upon principles the scientific accuracy of which scarcely admits of a doubt, yet there are many who still hold to theories no longer to be reconciled with the broader

and more recent generalizations of the laws of physical forces. Of the agencies possible and adequate to develop volcanic phenomena, there are only three, viz.: that due to combustion, which may be called chemical agency; that due to mechanical effect; and lastly, the theory of internal fluidity of the earth.

Let us examine briefly each separately, and see with what force they respectively commend themselves to our minds. We will not in this inquiry extend our investigations to cover volcanoes in general, but confine our inductions to the facts drawn from the Hawaiian group and from our own observations of Kilauea and the summit crater.

We will not consider here the very strong objections which might inferentially be established against the first theory by reason of the fact, observed by all who have visited the burning lake in Kilauea, that there is no flame—no combustion—no sudden burning of imperfectly consumed gases as they come in contact with the air—no indication of present chemical action—nothing but the clear fluid rock, poured out fresh from the great internal crucible in which it was fused. Taking no note of these, together with the further objection that may be urged by reason of the difficulties of maintain-

ing combustion under the ocean, we will examine and see whether even under the assumption of possible perfect combustion, the facts observed can be accounted for.

If the heat is developed by present and constant forces within or below the base of the mountain, it is of course maintained only by the continuous consumption of those elements which in their chemical union give it off. Whether it be possible to provide enough of this combustible material within the limited area comprised by these islands will depend wholly upon the quantity necessary to produce the heat that has fused such infinite masses of refractory substance.

As it is by the union of oxygen with various chemical elements that the largest amount of heat, and the intensest heat, is produced, we will consider this in our present inquiry as the heat-producing agent. The calorific values of the various substances uniting with this element are about as follows: for hydrogen, 62,032 units of heat; marsh gas, 28,515 units; stone coal, 13,720, and for sulphur 4,070 units. That is to say, the chemical combination of one pound of either of these substances with its proper equivalent of oxygen, would develop the number of units of heat stated.

By a unit of heat is to be understood that amount of energy developed which would raise the temperature of a single pound of water one degree Fahrenheit. That is, when one pound of hydrogen unites with a proper quantity of oxygen, the total heat evolved would be in amount equal to that which would raise 62,032 pounds of water one degree Fahrenheit; for one pound of stone coal 13,720 pounds of water one degree—and so on. This is the standard by which the absolute calorific energy produced by the chemical union of various substances is measured. This amount is constant and invariable, and is not dependent upon the degree of rapidity or slowness with which the union takes place, and is irrespective of intensity.

As it is impossible that a space adequate to contain the necessary amount of hydrogen gas should exist under these islands, we will look to the next highest source of heat among the solids—that is, carbon or stone coal. In a theoretically perfect combustion it requires 2.66 pounds of oxygen to each pound of coal. When consumed under conditions where the supply of oxygen is drawn from the atmosphere, it requires that which is contained in 12 pounds of air to completely consume one pound of coal. Now it must be confessed that it is

a liberal concession to this theory to admit the possibility of a requisite supply of unmixed oxygen at so great a depth and under the ocean. But to enable us to test the value of this theory, we will grant this, and even more, viz.: that the conditions of perfect combustion exist, and where the supply of oxygen is drawn from a source not in a state of mechanical or other combination with any other substance.

It is a well known fact that the temperature of different substances varies greatly, even when the amount of heat communicated is the same. This arises from the atomic structure of bodies, varying in which respect varies also in a corresponding manner the absolute amount of heat they are capable of containing. This is what is called, in the science of thermology, the specific heat of bodies. As before, in order to secure a uniform standard of measure, the heat unit is adopted. As water, of all substances except hydrogen, contains the largest amount of heat, or, as would be said, has the greatest specific heat, this is adopted as a comparative standard.

For the products of combustion—carbonic acid —we find for this value that its specific heat is .216, that is a little over one-fifth of water. In other

words, an amount of heat that would raise the temperature of one pound of carbonic acid five degrees Fahrenheit would raise the same quantity of water a little more than one degree. The specific heat of molten lava is substantially the same as that of carbonic acid, and its indicated temperature cannot be less than 3,000 degrees. As the products of combustion and the liquid lava are commingled in the process of fusion, it follows that they are of the same degree of temperature.

Now, as in the perfect burning of one pound of coal there is consumed 2.66 pounds of oxygen, there results as an aggregate product 3.66 pounds of carbonic acid gas. This, in the case under consideration, would have a temperature of 3,000 degrees. Were the specific heat of this gas equal to that of water, then at this temperature it would contain 3,000 units of heat; but as it is only .216, the absolute amount of heat will be only a little over one-fifth. Therefore 3,000x.216x3.66=2,371=the number of units of heat contained in the products of combustion at an indicated temperature of 3,000 degrees, resulting from the burning of one pound of coal.

As before stated, there are 13,720 units of heat developed, as the total theoretic calorific energy,

by one pound of coal completely consumed. Deducting the 2,371 units from this number, we have 11,349 units, as a residue to be wholly expended in the fusion of lava. As before stated, both the indicated temperature and the specific heat of lava being substantially the same as that of the gas by which it was melted, therefore 11,349÷3,000÷.216 =17.5=the number of pounds of indurated lava that could be melted by the theoretical heat produced by the burning of one pound of coal.

In before speaking of the probable origin of these islands (in the chapter entitled "Topography of the Pacific") I had occasion to point out the extraordinary declivity of this mountain range, when compared with that standard unit of angular inclination to be deduced from the various systems of mountain ranges when taken as an aggregate. From this the conclusion seems warranted that a hight of 13,000 feet was only possible and due to the usual geological agencies which have elevated the earth's surface into mountain ranges, and the remaining hight was the result of accumulated over-flow of lava.

As the superficial area of the islands is 6,000 square miles, the material projecting above water level would be quite sufficient, if uniformly distrib-

uted between the islands—as the water is comparatively shallow—to produce an additional area at the level of the ocean of an equal amount. We would have then—not computing the contents of a truncated cone the base of which was twice the breadth of the apex—12,000 cubic miles of melted matter which in long ages past has been discharged to build up these islands.

The numbers 1,290 and 1,820 stand respectively for the specific gravities of coal and lava. By this ratio we find that in order to produce heat in amount sufficient to fuse 12,000 cubic miles of lava, it would require the complete combustion of something more than 1,000 cubic miles of solid coal, or over four times the aggregate amount contained in all the coal fields of the United States. This quantity, if distributed in strata of the average thickness of coal veins throughout the carboniferous formation, would cover an area of nearly 1,000,000 square miles, or a surface more than double the sub-marine basic area of this group of mountain islands.

Allowing for the withdrawal of the oxygen which entered into combination with this amount of coal, there would be, as a total displacement of material substance, an amount exceeding 15,000 cubic miles. That is to say, there would be left as

a cavity, in consequence of this displacement, a space two miles in depth and nearly twenty miles wide, extending in a longitudinal line from one end of the group to the other, or a distance of nearly 400 miles. The transposition of so large a mass of material as represented by such a cavity can scarcely be made to harmonize with the building up of a mountain range whose angular inclination far exceeds any terrestrial range known.

Even were we to compute the amount of coal required, upon the basis of the actual amount of material that extends above the water line, the quantity would be that which by the ordinary ratio of distribution would cover an area of over 600 square miles, and the size of subterranean cavity caused by this displacement would be that occupied by a space one mile square and 300 miles in length. If therefore the heat necessary to produce the effects to be observed had had its origin in the source now under consideration, the subsidence caused by so great a displacement of material would constantly exceed by one-fourth the increased hight due to the outflowing lava, so that instead of the elevation being even that caused by the upheaval of the earth's crust, it would be much less, rendering it impossible for the summit of this

sub-marine mountain range to approach within several thousand feet of the surface of the ocean.

The origin of the heat as a mechanical effect accounted for by the second theory is based upon that grandest of all generalizations of modern science, the law of correllation and conservation of energy. To aid in an intelligible understanding of the application of this law to the solution of the question, it may be well to briefly glance at the leading principles embodied in this generalization. Before the development of those scientific truths that established the quantitative invariability of matter, there was commonly held, with the current belief that matter was subject, quantitatively and qualitatively, to the caprices of special agencies, creative and destructive, coexistent with the phenomena manifested by it, that kindred belief also in the mysterious nature of force, respecting its origin and continuity. Gradually there arose the belief in the indestructibility of matter, and in due time the essential postulate that force itself, the ever present and sensible manifestation of matter, was also indestructible.

It was but a rapid and easy step from this to the corollary that the various modes of force, before recognized as essentially different and discrete,

were in fact but correlatives of each other, susceptible by transmutation of being reduced to quantitative equivalents. Thus it is that light, heat, electricity, and other manifestations of energy, while in their general characteristics and outward evidences differing greatly, are come to be regarded correlates, and traceable to that one common origin, motion. As heat, or molecular motion, is convertible into molar motion—or motion of mass—as in the case of the projection of a cannon ball, so, conversely, is the motion of the mass convertible into atomic motion, or heat.

This law being once established, it became necessary to adopt some standard, or unit, to which all modes of energy could for comparative purposes become reducible. The foot pound, or unit of mechanical equivalent of heat, provides a universal commensurable standard. What is meant by the term "foot pound" is the amount of energy or power requisite to raise one pound weight one foot high. It is found by experiment that 772 foot pounds is an equivalent for one thermal unit. That is, the amount of heat necessary to raise one pound of water one degree Fahrenheit, would be also able to exert a force sufficient to raise 772 pounds one foot high, or one pound 772 feet high.

This will be better understood when it is stated that if one pound of water fell by gravity, free and unobstructed, through a distance of 772 feet, and the entire momentum of the mass, so acquired, were consumed in giving motion to the atoms composing it, the temperature of the water would be raised one degree. A familiar analogy will be found in the heating of a projectile when fired against a metallic plate.

This relation of mechanical effect to heat being definitely determined, it only remains to find the specific heat of any substance in order to know the hight through which it would have to fall, so that there would be developed in its mass the number of thermal units represented by its sensible temperature.

Heat is developed as an equivalent for mechanical energy not only by concussion of moving masses, but also by friction; yet different as may seem the two processes, the increased calorific intensity of bodies is due to the same identical primary cause in cases both of concussion and friction, viz., the vibratory motion of the atoms composing the mass. In the case of the conversion of molar motion into heat, the lineal visual motion of the mass is directly changed into invisible vibratory

motion of the atoms. In the case of friction, the pressure of the whole mass, concentrated upon a limited portion of its substance, disturbs that perfect balance of cohesive and repellant force, forcing the atoms within or beyond that neutral limit where an equal and opposing intensity gives the property of solidity and stability to matter in its normal state.

When there occurs, as in the case of friction of surfaces, sudden liberation of atoms so pressed within or drawn without this neutral line, the preponderating repulsion in the one case, or the attraction in the other, will impart a rapid motion to the molecules, which by virtue of an acquired momentum will carry them beyond or within the sphere of the two equilibrated forces, causing thus a succession of rapid vibrations of the atoms, which gives rise to the sensation called heat.

It is by this law of transmutation of mechanical energy into heat that many scientists seek to account for the origin of volcanic heat. As the crust of the earth is believed to be constantly approaching nearer to its center by reason of the supposed contraction in its volume, it is thought by the advocates of this theory that the force so represented, if converted into heat, would develop a sufficient

amount of this form of energy to produce all the calorific effects observed in volcanic action.

Let us see whether by the data of thermology, combined with those of observation, the results can be sustained which are claimed by the partisans of this theory. We have already taken the indicated temperature of fused lava as 3,000 degrees, and its specific heat at .216. Now in the conversion of mechanical energy into heat, were it possible to raise the temperature of water to 3,000 degrees, we would find that in order to acquire this temperature, it would have to fall through a hight of 772 feet multiplied by 3,000= 2,316,000 feet, or over 400 miles.

But the specific heat of lava being little more than one-fifth that of water, the same number of thermal units contained in an equal weight of this substance would indicate nearly five times the sensible temperature. Conversely, in order to exhibit the same—or 3,000 degrees of heat—it would be necessary to fall through that distance which would be an equivalent in foot pounds for one fifth the specific heat of water. We have found that the number of heat units contained in one pound of lava, at 3,000 degrees, was 648; therefore 648x772= 500,256 feet, or nearly 100 miles, which is the dis-

tance through which any given quantity of lava would be required to fall to increase its temperature 3,000 degrees.

That is to say: if the heat has its origin in this source, the whole mass which has been in a melted state would under this theory have fallen through a distance of nearly 100 miles, in order to bring it to that temperature at which it melts. Even allowing the possibility of a concentration within a limited space of heat developed by the falling of a mass fifty times as great as that of the solid contents of the whole group (and this is impossible, in view of the flexure of the earth's crust) it would even then require, to produce the effect, the subsidence through the distance of several miles of an area exceeding by many times the combined area of all the islands.

Nor would the result be in any way different if instead of concussion it were claimed that the heat was generated by friction; since simple pressure without motion produces no form of energy, and consequently no heat. This decline in the earth's crust, necessitated by the theory, cannot be harmonized with the existence in the same precise locality of the most abrupt upheaval known on the globe.

It is therefore to the internal fluidity of the earth that we must look for the only adequate agency by which volcanic phenomena can be produced. By a gradual reduction of the earth's temperature, caused by the incessant efflux of radiant heat from its surface, the solid crust of the earth grows thicker year by year. The contraction as a result of this decrease in temperature gives rise to unequal distribution of pressure, causing the lifting up of the earth's surface in some places, and in others a depression perhaps to some extent. This continuous and powerful contraction of the solid enveloping shell of the earth not only produces flexures, but must cause in many places profound fractures also, extending no doubt to the molten mass within.

Along the line of these fissures, which would naturally occur at the most elevated part of the upheaved area, would undoubtedly be located the various outlets from which volcanic cones are built up. From the unequal reduction of temperature there occurs an unequal contraction also, as between that portion of the earth's mass near the surface, and that portion more closely approaching the molten interior. This would have the effect to cause a pressure upon the liquid matter within, which would thus be forced upwards through the

fissures with greater or less pressure, according to the degree of inequality in the contraction of the inner and outer mass.

For the displacement of the 12,000 cubic miles which we have taken as a proximate estimate of the solid volcanic contents of the islands, a reduction of the earth's diameter by only 8 inches would be required. Let us pursue this idea one step farther, in order to show the utter inadequacy of the theory of mechanical energy to account for the igneous action of volcanoes.

Taking the solid portion of the earth at fifty miles thickness (about that assigned by scientists) we would have falling towards the center of the earth through the distance of four inches—in order to displace the amount of molten matter stated—9,600,000,000 cubic miles of solid matter. This mass falling through the distance of four inches would develop an energy sufficient in amount, if converted into its equivalent of heat, to raise the temperature of the whole mass less than one four-hundredth of a degree Fahrenheit, taking its average specific heat at .216, the same as that of lava.

If this total amount of heat was conceived to be concentrated into 12,000 cubic miles of lava, the temperature would become 2,000 degrees, since the

intensity increases in the direct ratio of decreased volume and as in the case assumed the mass becomes reduced to $\frac{1}{800,000}$ of the volume, the temperature would be increased also 800,000 times, or to the degree stated. Thus we see if the total theoretical quantity of mechanical force represented by that amount of contraction of the entire solid portion of the earth necessary to displace 12,000 cubic miles of liquid matter were concentrated in the latter mass, it would fall short by 1,000 degrees of producing the heat actually existing.

CHAPTER XVIII.

Trip to the Crater of Mokuaweoweo.

There are some experiences of our lives that are so completely satisfying that we do not care to have them repeated, even though we were to live to the age of Methuselah. Such was our trip to the summit of Mauna Loa. This is a journey of indescribable hardship, fatigue and danger, and is one very seldom taken by the islanders themselves, and never, I believe by tourists. The summit of this mountain has been visited only six times altogether, and when it is remembered that there is on the summit the finest volcanic display in the world to reward the toil of the ascent, some idea of the difficulties that are in the way may be formed from the few times it has been visited.

This is therefore a comparatively new field for the traveler and we were somewhat ambitious to achieve distinction as bold volcanic explorers. I don't feel that way now. My ambition is satisfied and nothing short of an attempt of Mauna Loa to

disembowel itself would tempt me to return to its dreary, solitary summit. Commodore Wilkes, of the United States expedition, is supposed to have been the first to make the ascent. He was, I believe, sent out by the United States government to make a survey of the island in 1840. He, therefore, prepared himself for this expedition in the most complete manner. Besides the ordinary equipments provided by the government, he took with him several hundred natives as guides, servants &c.

The terrible accounts which he has given of the hardships endured, the number of natives that perished from cold and mountain sickness, was not calculated to strengthen us in our resolution. But as so little is known about the summit crater, and as there exists a need of more definite information concerning its dimensions and general characteristics, we felt that if we could supply this to the world it would be something of a scientific achievement.

This was an added inducement to the ordinary desire to gratify the spirit of adventure. We were told at Honolulu that an accurate survey of the crater was much desired, as some dissatisfaction existed as to Wilkes's measurements, the accuracy

of which were doubted, as he is said to have obtained his base line by sound. When we announced our intention to make the ascent we were usually met with a smile of incredulity—a kind of "Try it and you will see!" expression of countenance. Some thought that if it was in September we would stand a better chance, as the snow would not then offer the impediment that it did in the month of June.

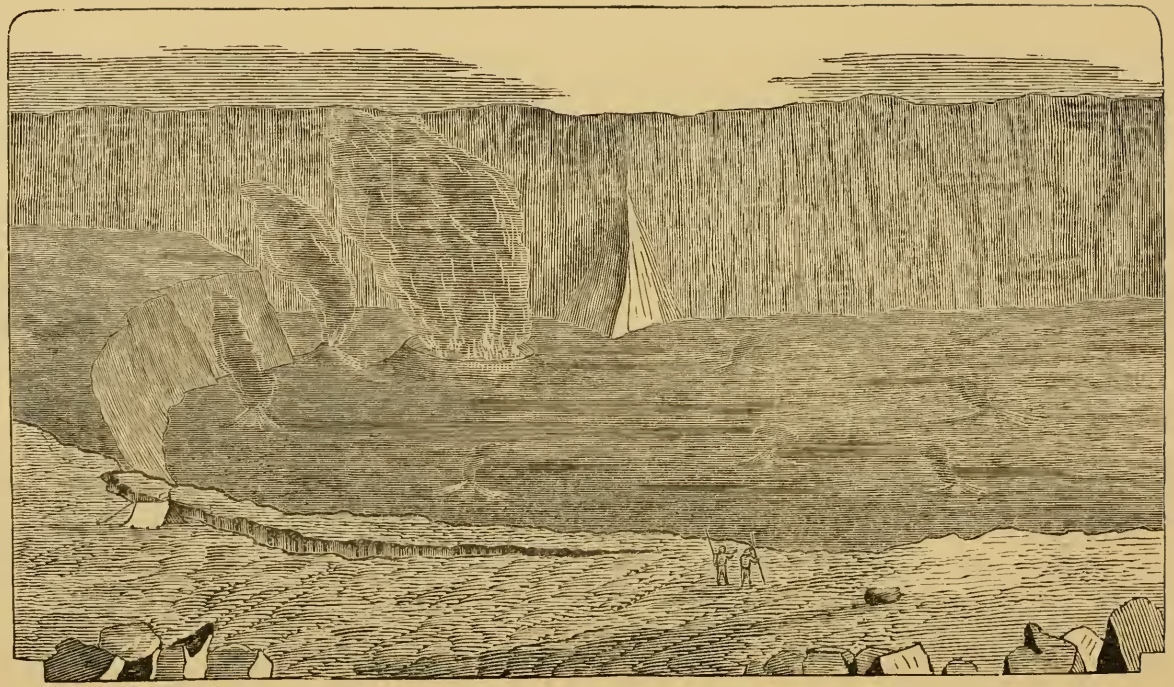
At Hilo we mentioned our design to Mr. Reede, within whose ample ranche this portion of the mountain is included. Upon inquiry whether he had ever been to the summit, he replied that "he had lived there for forty years within twenty miles of the summit, and he had never went to the top, and if the Lord spared him, he hoped he never would go." This was anything but encouraging, but as the true American never backs down from a job he has undertaken, we concluded to put it through.

Sending one of our guides, with tents, &c., direct to Ainapo, the point of departure, we went to Kappapala, some fifteen miles further to the south, where we left Mrs. B. until our return. To our great delight we found here awaiting our coming two young gentlemen, Messrs. John Lyd-

gate and William Shipman, residents of Kappapala. They had heard of our coming and intended ascent of the mountain, and concluded to join us. This was especially fortunate, as Mr. Lydgate is a gentleman of scientific attainments, and also added to our outfit valuable instruments for use on the summit.

At Ainapo we met a half-caste—a Mr. Henry Gandol—a veritable Hawaiian Kit Carson, of whom many marvelous stories of adventure are told. As he is more familiar with these wild mountain regions than any one else on the island, we finally induced him to accompany us as a further precaution for safety. Our first day's journey brought us to the limits of vegetation, near 7,000 feet above the ocean. Here we encamped for the night.

Early next morning we continued the ascent. We soon left behind us every vestige of vegetation, and found ourselves in an interminable sea of barren lava rising in great billowy masses, towering one above the other in the direction of the summit. We painfully and slowly mounted upwards over the steep craggy ridges that joined one another in endless succession. Immense blubbers of lava stretched their thin treacherous shells across our path, through which our horses would often break,



CRATER OF MOKUAWEOWEO.

lacerating their legs and splintering their hoofs so that their legs were soon bathed by the freely flowing blood in a crimson gore.

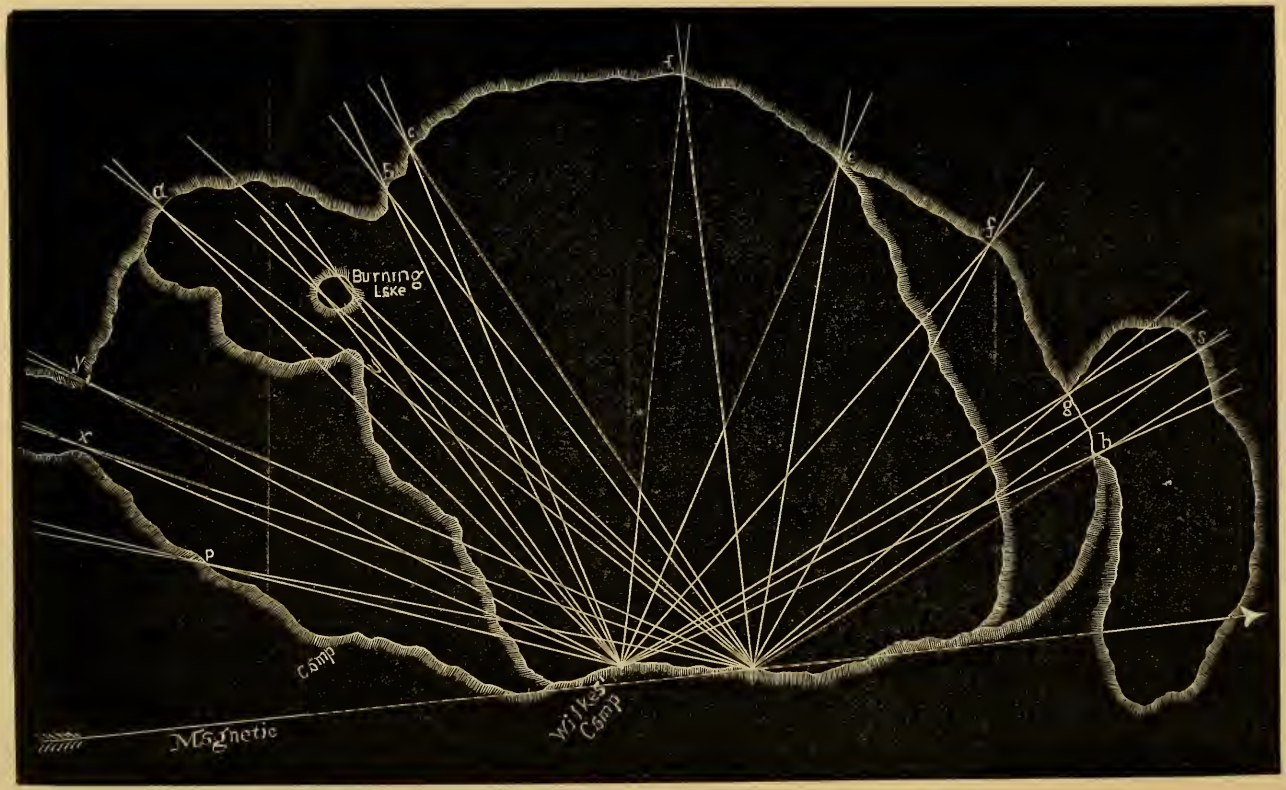
At the hight of 12,000 feet we came to the limits of perpetual snow. Here in the gorges and low spots the snow was drifted in immense ridges and banks. It was a strange sight to see in the tropics, right under a vertical sun, fields of snow acres in extent reflecting from their chilling surface the clear rays of the sun with a dazzling brilliancy. We were much troubled at first by these drifts of snow, as our animals, having never before seen so strange a sight, took fright at their near approach to them, nor could the vigorous use of Mexican spurs, big as saucers, induce them to go near it.

This was a serious matter, as it compelled us to cross immense ridges of lava, which are well nigh impassable. Finally, by much urging and some familiarity, our horses at last ventured upon the snow, it being dense and firm enough to support their weight. Some two or three miles distant from the crater the incline is very gradual, the summit being in reality an immense dome of gentle curvature. Here the mountain forms its own horizon, and the entire world is shut out, not even the wide expanse of ocean being visible. This was desola-

tion and solitude complete. The sky being clear, not a cloud was to be seen. Even the belt of clouds that continually wreathe the mountain half way up was shut out.

There was absolutely not a living thing on the earth or in the air, not a spear of grass or even the hum of an insect to relieve the dreadful, oppressive solitude. Nothing but a wide, weary waste of "pahoehoe" lava around us, with the clear blue dome of the sky shutting down upon us. The sense of isolation was terrible. I almost felt that even a flea bite would be a relief, as it would have given at least the comforting assurance that the world had not withered up, and all animate nature had not become extinct. We at last reached the crater and camped on its very verge. Our hight was now over 14,000 feet. At first we did not feel much discomfort from the rarefied air, and except that we could not exert ourselves for but a few minutes at a time without becoming exhausted, we would not have realized that we were at such an immense hight.

While the Professor was busy selecting points of observation, Mr. Lydgate and myself carefully measured our base line. This we did along the very edge of the crater, which descended in a per-



SURVEY OF THE CRATER OF MOKUAWEOWEO.

pendicular wall nearly 800 feet. We measured a base line of 1,876 feet. From this we took 22 different angles, both horizontal and vertical.

The following are the angular measurements of the crater, taken by Mr. Lydgate and Prof. Geiger:

Angles from S. Base N.		Angles from N. Base S.	
North Base	0° 0′	South Base	0° 0′
h	26° 0′	p	8° 49′
s	30° 53′	x	15° 50′
g	33° 04′	y	20° 53′
f	51° 0′	a	35° 45′
e	68° 40′	East end of lake	38° 51′
d	86° 0′	West end of lake	40° 56′
c	114° 42′	b	50° 35′
b	118° 37′	c	54° 30′
West end of lake	128° 20′	d	81° 25′
East end of lake	134° 45′	e	97° 45′
a	137° 0′	f	117° 15′
v	137° 37′	g	137° 27′
y	154° 46′	h	146° 0′
x	160° 40′	s	N. 29° 30′ W.
p	168° 40′		

Elevation of west wall; angle at N. Base d 2° 34′; distance 8,590 ft. from N. Base and 8,514 from S. Base.

I now began to feel the effects of our altitude. My pulse quickly ran up to a frightful pitch and beat a lively tattoo of over 160 per minute. About sundown we were all seized with an intense headache, and the entire party quickly became very sick. We all threw up as lively as though on a

vessel in a storm, and altogether suffered all the horrors of sea-sickness.

As our camp was located on the very rim of the crater, we could look directly down upon the very lake below. It is much more active than Kilauea, never for an instant ceasing its flux and reflux of molten lava, which was white hot throughout its entire surface. It was quite as liquid as water, immense waves circling outwards and dashing against its enclosing walls, whenever an unusual upheaval in the center occurred. There were many fountains throwing up their livid spray from 50 to 100 feet high, descending with a splash into the moving mass beneath. There were hundreds of little jets popping up and down incessantly around and among the larger columns. The whole looked as if the "old fellow" had summoned his imps for a night's revel, and they were dancing a lively schottische on this white-hot floor. As the night was dark the minutest feature of the lake was revealed, even to the bluish tint of the half-consumed gas as it rushed out with a loud, explosive report, carrying hundreds of tons of lava in a fan-like column high above the surface. Some idea of the intensity of this heat may be formed when it is remembered that lava is a very obdurate

substance, and quite as difficult to melt as brick; yet immense cakes of it, tons in weight, I have seen fall into the lake, float for an instant, rapidly change color, and in a moment more melt and disappear.

This lake is about 800 feet in diameter, and, like Halemaumau, at Kilauea, is flowing over in large red streams into the main bottom below. We are somewhat proud of the fact that our survey is regarded as the most accurate one yet made. In fact, there has only been one other attempt made —that by Commodore Wilkes, spoken of. One result of this survey will be to deprive Kilauea of the proud distinction she has long enjoyed—that of being the largest crater in the world. She must now rank second, as Mokuaweoweo is, as we found, something over nine miles around, and from 800 to 1,000 feet deep. The walls are sheer precipices, and in many places over-arching. It has the same blackened appearance on the interior mural surface as Kilauea and Haleakala, the effects of the intense heat to which the whole face of the rock has been subjected. Although, to all appearances, it is next to impossible to effect a descent into the crater, I had the temerity—recklessness rather—to attempt it. After an effort of several hours I

abandoned it, after having made a descent of a few hundred feet.

This was, I confess, a rash and foolish undertaking, and well nigh cost me my life. The walls of the crater for some distance back are cleft by many fissures, only a few feet wide and in many cases hundreds of feet deep. They are formed by the cracking away of the perpendicular wall, thus falling in immense flakes into the crater below. They are so often to be met with, and we had stepped over them so frequently, that we at last came to cross them without fear. On my return, wishing to save the distance around, I as usual attempted to cross directly one that lay across my path. It being of unusual width, I feared to leap over it, and seeing near by a mass of rock that seemed firmly wedged in the fissure, I placed my foot upon it, thus intending to step over.

I had scarcely touched it when the whole mass, which had only been loosely suspended, gave way and descended with a thundering crash into the depths far below. Fortunately I quickly recovered my balance before it was too late. *I went around that fissure*, and took a bee line for the camp, musing upon the truth of that adage that "the longest way round is the shortest way home."

It was very cold on the summit during the night, the water freezing quite hard in the canteens. With all our efforts we could not keep warm, and in the morning we were all quite stiff from cold. Our whole company passed a wretched night, growing sicker, if possible, as the night advanced, nor did we find any relief until we had descended about 7,000 feet.

After we had descended some 4,000 feet we encountered the upper surface of the clouds, and for four hours we wandered, and groped, and stumbled, in a dense envelope of vapor, so thick that you could scarcely see three mules' lengths ahead. As there are literally no landmarks, nothing but the same unvarying sea of "pahoehoe," the unerring skill with which these Kanakas reach an objective point is little short of the marvelous. They seem to be guided by instinct.

We reached Kappapala the same evening. I am not now sorry that I made the trip, but would be very sorry to be compelled to repeat it, it being, as I believe, the roughest route in the world.

CHAPTER XIX.

Mud-Flow in Kau.

Some four miles distant, and in view from Kappapala, bearing away to the southeast, is a ridge, one of many which on all sides of this mountain spring from the base like the spur roots that sustain the trunk of a tree. Along the base of this ridge—it would be called a mountain range in America, as it is from 2,000 to 4,000 feet high—extending for several miles outward therefrom at a gentle decline, lies the most lovely of valleys. Over its whole surface was spread a rich carpet of perennial verdure, and scattered here and there were clumps of Kukui and Oheia trees, under whose friendly shade congregated, from the rich pastures around, droves of well-fattened cattle, horses and goats, which in drowsy herds here found a safe and pleasant retreat from the scorching rays of a noon-day sun.

Nestled in groves of palms and under the spreading branches of the mango, in his rude hut, plaited

from the pliant fibres of the Lauhalla, the leisure-loving native rested in ease, peace and fancied security. All along the foot of the ridge, the upland limits of the valley, for miles, there was a succession of these primitive houses of the islanders, which at a point about midway from Kappapala to Ninoli thickened into a small irregular village. Taken as a whole, it was one of the most pleasant pastoral scenes that ever dwelt in the fancy of a poet.

Here we would think, with the open plain below, and the gently receding slope above, perfect security was assured the dwellers in this little paradise, and no sudden calamity could befall them, even in a region where law and order gave way to the phenomenal, the accidental. Yet in an ill-starred moment, a swift and frightful desolation and destruction swept over and transformed this beauteous scene into a hideous ruin.

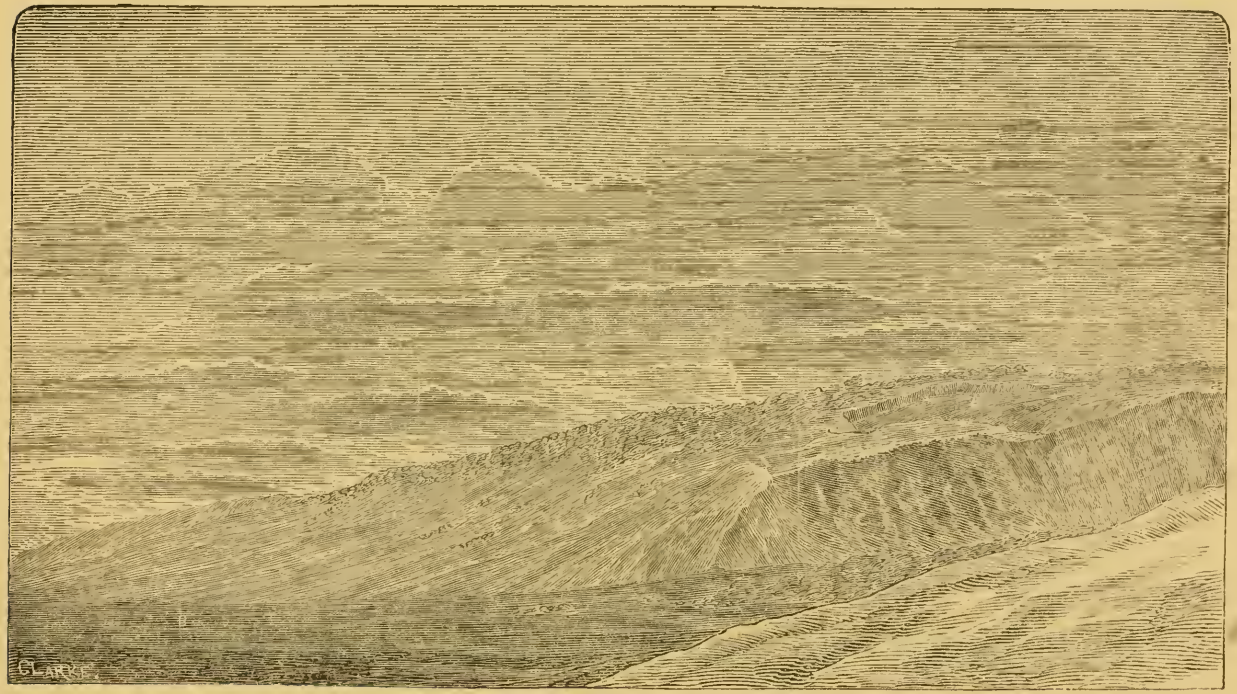
During the afternoon of April 2d, 1868, at the time that the great earthquake wave swept through the island, a large tract of land resting on the face of the mountain some 2,000 feet above and a mile and a half distant from the little village, by some mysterious operation of nature was hurled in a commingled mass of stones, earth and water upon

the valley below, extending in places to several miles from the foot of the mountain. As if under a special mission of destruction, it sought out the most pleasant portion of the valley and buried under its crushing mass the unsuspecting village in its midst.

So great was the volume of matter that it covered an area of nearly two square miles, which varied in its depth from two feet at the edge to thirty at the middle. There were buried beneath it some thirty natives and from five hundred to one thousand head of horses, cattle &c.

The projection of this matter seemed instantaneous, and was accompanied with a flood of water which continued for days to pour down the mountain side in great quantities. The limits of the space occupied by the mass on the mountain side are quite sharply defined, and plainly visible at a distance of many miles. It was in size somewhat less than it now occupies in the plain below.

As this is regarded as the most mysterious of all mysteries in these islands, we devoted some time to an examination of it, with a view to deduce if possible a theory of its origin that would co-ordinate with the facts. We therefore took many measurements in the valley and at the bottom of



SCENE OF THE MUD-FLOW IN KAU.

A, Locality of Slide on Mountain; B, Present locality in Valley.

the slope, being the more accessible localities. We were thus limited in our explorations by the unfortunate circumstance that there are almost continuously hovering near the summit—and thus in the locality where the eruption had its origin—torrents of rain which effectually prevent any explorations in that quarter at such times. But I am happily furnished with an accurate measurement of this locality, for which I am indebted to my friend Mr. John Lydgate, who after our departure completed a careful survey, which he has kindly forwarded.

By these measurements it is found that the distance from the center of the area marking the site occupied by the earth before its removal, to the center of the mass as it now lies spread out over the valley, is over two miles, and the extreme distance from the upper to the lower edge is over four miles. Thus there are millions of tons of matter now lying in the valley, fully four miles removed from the position it occupied on the side of the mountain. The weight of the entire mass cannot be far from 40 to 50 millions of tons.

That so large a quantity of material should be transferred through so great a distance in the lapse of a moment is sufficiently wonderful; but what adds greatly to the mystery, and renders it appa-

rently impossible of solution, is a fact which I will now point out. The general feature of this phenomenon, it will be noted, is the change in position, through an average distance of three miles, of a tract of earth 1½ miles square, and of a medium depth of 12 feet. Along the slope, upwards at a distance of about 900 feet from the base of the mountain, there stood a native thatched hut, surrounded by a few Kukui trees.

This hut was in a direct line which would join the centers of the two areas above and below, viz.: that of the vacant space above, and that which marks the space now covering the valley below. It was therefore in a line coincident with that traversed by the mass in its change of position. At the time of the occurrence, this hut was occupied by a native and his family; and miraculous as it may seem, this whole vast volume of matter, containing trees of great size, stones hundreds of tons in weight, all passed directly over this hut without the slightest harm either to the structure or its inmates. Indeed, at the time they were even blissfully unconscious of the fact that a small continent, with a river or two thrown in, had passed over their heads.

I also observed that there was a distance of

about 900 feet which bore no evidence of any of the material having touched it, as it was covered with an unbroken sward. It would thus seem that for a distance of at least 900 feet the entire mass took a clear flight through the air.

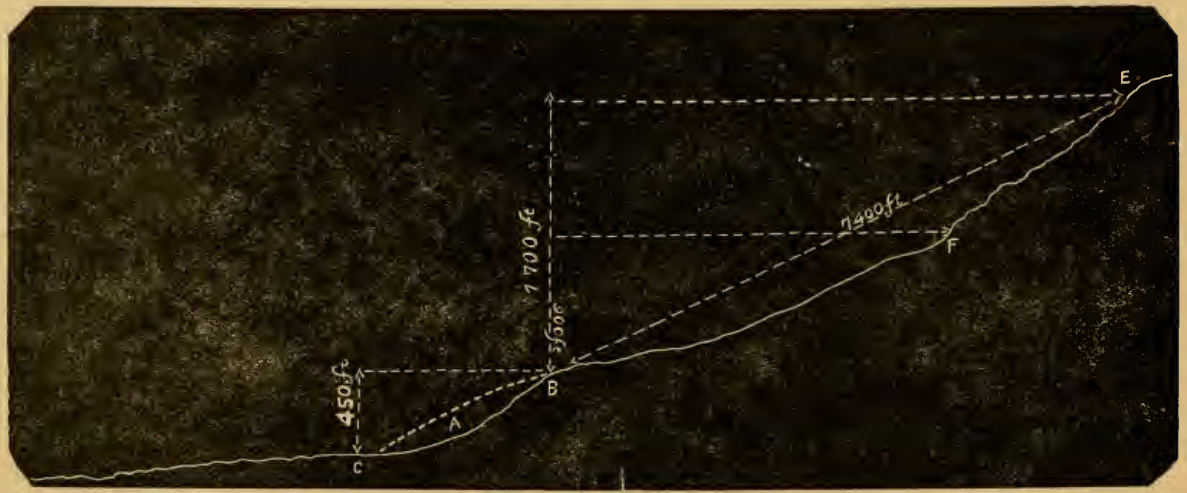
Although it is called by the residents a mud-flow, yet the fact that through a portion of the distance it did not come in contact with the earth at all, renders it seemingly impossible to explain it upon the theory of a simple land-slide. The theory therefore has become current and to a great extent adopted, that it was driven off of the face of the mountain by an internal explosive force and hurled bodily over the distance traversed by it. The origin of this force is variously ascribed "to the sudden generation of steam by coming in contact with the heated matter under the surface," to the explosive power of confined gases &c., &c.

But to all the theories based upon the sudden application of a projectile force, the unanswerable objection can be raised that a force so great as would be necessary to impart instantly such an initial velocity to forty millions of tons of solid matter as would carry it by its momentum so acquired through an average distance of three miles, would certainly produce a concussion for miles

along the face of the mountain at least sufficient to seriously disturb all movable objects resting within such limits. But this was not the case. Even the frail native hut, located only 2,300 feet from the lower edge of this supposed exploded area, remained without the slightest injury. If the theory of applied internal force were correct, it does seem to me that the resultant concussion, even at that distance, would have been sufficient to have shot the inmates through the roof like sky-rockets.

Believing the explosive theory utterly untenable, I examined the surface features with some degree of care, to determine if there was really any insuperable obstacle in the way of accounting for the phenomenon wholly upon the ground of it being an ordinary land-slide.

Although the face of the mountain presents an apparently uniform surface, sloping with what seems a regular incline, yet in reality there are many irregularities of surface, it being terraced in many places. On examination it was apparent that at a distance of a few hundred feet above the spot where the hut stood, there began in an abrupt manner a declivity of a much sharper grade than the average above and below that point, forming at its upper extremity a marked offset, and below



SECTIONAL VIEW OF MUD-FLOW.

joining the bordering valley at a much more acute angle than would be produced by the prolongation of a surface having the same general angle of inclination as that above.

On inspection it was found that for the space of a hundred feet or so extending from the verge of this offset, the ground approximated somewhat to a horizontal position. The accompanying diagram will show this variability of surface inclination, A being the point where the hut was located, B C the section of sudden and increased declivity, E F the denuded area consequent upon the displacement of the material forming the slide.

The distance from B to C I found to be about 900 feet and the hight, by barometric reckoning, was 450 feet. The distance from the edge or offset, B, to F, the lower edge of slide, was found by Mr. Lydgate's measurement to be about 2,000 feet, and the perpendicular hight of the latter above the former 900 feet. The distance from the same point to the upper edge of slide was 7,400 feet, and the perpendicular hight 1,700 feet.

Thus it will be seen that the angle of inclination was for the first or upper grade in the ratio of 1 to 4.5, and for the lower section 2. The question therefore to be determined is, when regarding it

as a simple land-slide, whether there can be deduced from the data contained in this problem, under the hypothesis stated, the result shown by observation; or in other words, whether from the hight above the point B there would be a velocity sufficient acquired by gravity to cause the mass to leap over the intervening distance of 900 feet, and also whether the trajectory of the mass, as a resultant of such conjunction of forces, would be such as to give the required elevation above the sloping surface.

It is obvious from the difference in vertical hight of the upper and lower portions of the slide that there must also exist corresponding differences in velocity at the instant of its approach to the point B. There is also another cause which would operate to produce further inequality of motion. From the point B to F there is an intervening space of 2,000 feet, the irregularities of whose surface, together with other objects, such as trees, loose rock, earth &c., would interpose constant checks to the progress of the mass in its descent. To the lower portion of the slide, therefore, would be presented obstacles to its motion to which the upper portion would not be subject; and as a consequence of this reduced resistance to its gravity, as

well as the greater altitude through which it would descend, there would be as between the upper and lower portions a wide diversity of velocity as it passed the point B.

The degree of retardation which a mass thus descending would suffer is dependent upon both the nature of the moving material and the character of surface upon which it rested. Observers all agree that the site of the dislodged mass was but a soft, swampy tract. The material, after the flow into the valley, is described as of soft, clayey, semi-liquid character, which for months after was not of sufficient firmness to support even the weight of a man. It seemed in fact to be a combination of earth, stones and water, the latter in such quantities as to make of the whole a sort of thin mortar.

The denuded surface left by the dislodgement of the material above, as well as that from the lower edge to the point B, was solid rock. It seems therefore probable that the thin, slippery, boggy substance which had accumulated upon this rocky surface had by the tremulous jar of repeated earthquake shocks become loosened and by its gravity flowed down with resistless force and impetuosity. The descent was no doubt greatly aided by the contained water in the mass, of which there

was an immense volume, since for months afterwards a large stream poured down the mountain side, having its origin near the center of the denuded tract, which still flows in considerable quantities, though the lapse of eight years has intervened since it burst forth.

The theoretical velocity of a body falling through a distance of 900 feet, the perpendicular hight of F above B, is 240 feet per second. By the coefficient of friction of various bodies, we find that were the surfaces smooth and uniform, the velocity acquired at the point B by virtue of a descent through 900 feet vertical hight, and where water or other fluids interposed between the surfaces, would be 180 feet per second. Allowing for irregularities of surface and other impediments, we believe a velocity of 140 or 150 feet per second would be realized by the descent of a mass of such great weight, and consisting in so large a part of so mobile a fluid as water.

Now from the point B to C, there is a perpendicular hight of 450 feet. A body falling freely and without resistance, under the influence of gravity only, would occupy 5.4 seconds of time in descending through this space. The substance of the slide, by reason of the almost horizontal surface imme-

diately above the point B—though only of limited width—would move, as an initial direction at that point, on a line also nearly approaching a horizontal.

Therefore, as the velocity of descent which we have assumed as probable is about 145 feet per second, and as the time required in falling through the vertical distance from B to C is 5.4 seconds, it follows that the trajectory as a resultant of the combined influences of gravity and the primary lineal velocity stated would be such as to carry the mass to that distance represented by 145x5.4, before it again came in contact with the earth. This distance would be 783 feet, or very nearly the distance actually observed to exist between the points.

The theoretical velocity of a body falling through the distance of 1,700 feet would be about 330 feet per second. Taking into account the fact that the lower portion of the sliding mass in its descent removed such impeding matter as lay in its path, and from its own substance filling to a regular, uniform surface any existing roughness and irregularities; and taking likewise into consideration the fact that a much larger volume of water also descended from this locality, it is there-

fore highly probable that the actual velocity of that portion descending from the extreme upper limits bore a much larger ratio to the theoretic velocity due to a body falling through the same hight than that descending from the extreme lower limits. This velocity, under the conditions stated, would not be far from that to be deduced from the co-efficient of friction for bodies between whose surfaces a liquid interposed.

This would give for the material from the extreme upper edge a velocity of 240 feet per second. The material of this portion of the slide would therefore be carried from the point B to a distance equal to 240x5.4=1,296 feet, before it again reached the earth. If this difference in velocity which we have sought to demonstrate really existed, then it would follow as a natural result that the arrangement of matter, as respects the order of its position, would be reversed, since that portion falling through the lesser hight would by reason of its less contained momentum be carried to a shorter distance into the valley below than that falling from a greater vertical hight.

And here the theory receives a strong confirmation in the fact that the material which came from the highest altitude on the mountain now lies at

the extreme further edge of the flow in the valley, while that from the lowest level lies nearest the foot of the mountain, being thus inverted, a result to be expected as a consequence of the difference in velocity pointed out.

It remains only to determine whether the momentum due to the velocity assumed would be sufficient to force the mass to the distance it now occupies from the base of the mountain. In the unobstructed passage from B to C, the mass would be accelerated in its velocity over that at the point B, at least 120 feet per second. This added to the velocity of that portion from the extreme upper edge would make a total of 360 feet per second at the instant it came in contact with the earth below the point C. As the decline from this point to the farthest extremity of the flow is nearly 400 feet, the angle of inclination would approach to a measurable coincidence with the direction of the motion of the mass; so that the whole—or nearly so—of its momentum would be consumed in forcing the material over the surface of the earth.

The velocity of 360 feet per second represents, for the "*vis viva*" of a body, that amount which under a constant resistance equal to its own weight would be sufficient to carry it to a distance of

nearly 2,000 feet. That is, if a moving body of one pound weight had a motion in any direction of 360 feet per second, the power for which this velocity was an equivalent would be sufficient to overcome a constant resistance of one pound through a distance of nearly 2,000 feet. If, as in the case under discussion, the only resistance to overcome was that due to the friction between surfaces, for which in the present case one-third may be regarded as a liberal estimate, then the distance to which a body would be carried under the impulse due to that velocity would exceed that where the resistance was equal to the weight by an amount inversely in proportion to the ratio of co-efficient of friction to the total weight of the mass.

Taking the co-efficient of friction at .33, (rather above than below the real one) the momentum due to the velocity we have found would therefore be ample to carry it to the distance of 6,000 feet down an incline of 1 in 14; and this will not vary in a material degree from the length of the flow which really exists, from the base of the mountain to the extreme lower edge in the valley.

CHAPTER XX.

Homeward Bound.

It was originally our intention to go around by the way of Waihinu, through the pleasant coffee and orange groves of Puna, and thence by the little Indian hamlet of Honokua to Kealekakua Bay, where in respect to Capt. Cook—who was killed at this place by the natives—we had thought to shed a few tears on the enshrined spot of his martyrdom. But as we had already visited coffee-groves on Maui, and had surfeited on the guavas and oranges of Kauahai, this part of the programme had but little attraction for us.

As to the latter inducement, as we progressed on our journey, and the nearer we approached the locality where the historic event occurred, the more numerous became the native versions of this unfortunate affair; and such was the coherent thread of credibility that ran through them all that we began to suspect that as in all things else, *this* story had two sides to it. In fact, we found

ourselves almost forced to the unwilling belief that the credence gained by that version which has been popularized throughout Christendom was not so much owing to the inherent truth contained in it as to the superior facilities afforded by civilization over that of mere native oral transmission and tradition for propagating it, whether true or false.

But still we preferred to cherish love's young dreams, and we did not propose to yield up on insufficient evidence a belief which had as a warrant for sincerity the early impressions and trust of confiding childhood, and as a guaranty of absolute truth a long and undisputed array of historical proofs. It is true that the latter came from one side and were drawn from one source only, and for the especial purpose of vindicating the honor of the gallant captain; yet it is essential, in order that we may rest secure in the enjoyment of the pleasing delusions of our schoolboy days, that no rebutting testimony be admitted, especially from a heathen source. And moreover, is it right, is it reasonable, to expect that in behalf of a few benighted, unregenerate heathen, Christian civilization should be restricted in the exercise of that grandest of its prerogatives, the right and power to suppress as well as disseminate truth?

We therefore steadfastly refused to believe, and at first lent an unwilling ear to the native recital of the long catalogue of wrongs and injuries suffered by them at the hands of Capt. Cook. How for months they had admitted him without restraint into their hospitable homes, welcomed him throughout all the districts of the islands, gave him of their scanty store with a generosity characteristic of these people—a quality that even now wins the heart and excites the unbounded admiration of the traveler—and how, in return for all this, in the most wanton manner he betrayed their confidence, kindness and hospitality, treated them with cruelty, brutality and contempt, even violating the sanctity of their domestic relations. All this, a new revelation to us, grated harshly upon ears attuned to the witching dreams and romance of early days, and the unpleasant suspicion came over us that it was another case of misplaced confidence.

Although we were not wholly converted to the new phase of the story, yet we had heard so much of the doings—the shameless conduct of this gay old buccaneer—that by the time we arrived here, the fountains of grief had pretty well dried up; so that were we even to endure the hardships inci-

dent to a pilgrimage of a hundred miles, we were not sure that we would find in an old cocoa-nut stump—the only remaining witness of the sad tragedy, now in the last stages of decay—a sufficiently touching reminiscence of this melancholy occurrence to open the flood-gates of our sorrow to any great extent.

Besides, as we had already, in our school-boy days, invested in this arrant humbug about all our surplus sympathy and tenderness, we thought that at this time it would be both unwise and unprofitable to levy any further assessment upon our credulity. We therefore thought we could not do his memory justice, and so concluded to let the gallant captain rest in peace—or rather in pieces, as it is said the outraged and infuriated natives literally tore him into fragments.

We accordingly decided to return to Hilo *via* Kilauea, and by the same route by which we had reached this place, being induced to do so not only from the desire to take one more look at the grand old crater, but also to complete our collection of specimens and superintend their preparation for shipment, since they had to be carried to the coast on pack mules.

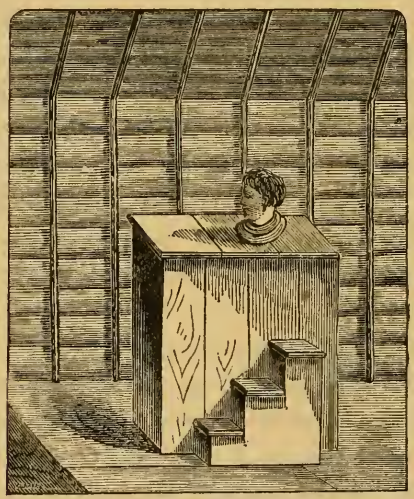
Among the objects of lesser interest and attrac-

tion here is the sulphur bed located near the northern verge of the crater. In this locality is an unusual number of fissures, through which escape, in dense columns, volumes of steam carrying with it in large quantities the volatilized vapors of sulphur. As it comes in contact with the colder air of the surface, a sudden and partial condensation of steam ensues, and also that of the sulphurous vapors, which latter gradually accumulate in masses of iridescent crystals, of indescribable beauty both in the delicacy of form and line, which unfortunately for the collector are as fragile as beautiful.

As this has continued for ages, it has in the process of time built up a huge ridge of almost pure sulphur, from which large solid blocks can be taken with but little labor. By carefully wrapping some of the more enduring and substantial specimens in the soft silken substance of the pulu, we managed to preserve somewhat of their original beauty and form.

At the base of the ridge is located a sulphur bath quite original in design and construction, and fully as efficient as unique. Over one of the fissures that emits a vapor somewhat less in temperature than others—that is to say, not quite red hot

—a grass hut is built. Within this is a rude box, at the bottom of which the hot vapors are admitted directly from the crevice in the earth, the flow



A SULPHUR BATH.

being regulated by a sort of fly-trap or winged valve made out of a piece of plank.

This is closed at the top by a movable cover composed of two pieces meeting in the middle, in the respective halves of which is a cut a semi-circle, so that when joined together they form an

aperture of size sufficient to admit the neck of the unfortunate who in a misguided moment should be betrayed by curiosity into the broiling atmosphere of this little Tophet. When once in position the two halves of the cover are closed about the neck, and a towel is also wrapped closely to more completely exclude the fumes of sulphur, which are so strong as to quickly produce suffocation if not entirely shut out.

Three minutes is thought to be long enough for a good, effective bath. I should think that was plenty—in fact, a liberal allowance. Indeed, as far as our experience goes, we thought three seconds better; or at least that is quite long enough to cause one to moult to the toe-nails if not too thick-skinned. The first effect is sufficiently startling, and is very similar to what would be produced by the sudden discharge of the contents of a steam-boiler on one's naked person. At first we thought our attendant had made a mistake, and instead of vapor had turned on a stream of hot lava; but he said it was all right, and gave us the comforting assurance that we would soon get used to it.

Perhaps that was true; but we had no notion of getting used to it, as we felt sure that would only

happen when we had been converted into a mummy. I began to feel a little uneasy when the unpleasant suspicion flashed through my mind that it was not a sulphur bath after all—only a decoy—simply a trick of these heathen, who instead of eating people raw as they used to, had so far yielded to the influence and customs of civilization that they now took them boiled. We therefore suddenly discovered that we were perfectly healthy, and really did not need a bath any way.

So precisely at the end of one and three-quarter seconds we signified our belief that we were thoroughly cooked—well done—in fact sufficiently tender for the most cultivated cannibal palate. We also added, in a persuasive sort of way, that by the Great American Eagle, George Washington and Capt. Cook, if he did not instantly turn his throttle he would think a small volcano had fallen on him. Whether it was due to the sadness in our eye or the dread inspired by the recollections of Capt. Cook, or whether he preferred us half raw, I do not know; but he responded with an alacrity that was pleasing, and we crawled out of our vapory sepulchre in a magnificent state of perspiration and an odor like a match factory—with steam enough in us to run a 40-horse engine, and with a

skin stimulated to the ruddy hue of a parboiled lobster.

After taking a careful inventory of our damaged anatomy, we found that at a low estimate we had lost an amount of cuticle upon which, if converted into parchment, we might have written the whole history of the islands. If we are ever again seized with the insane desire to indulge in the luxuries of a sulphur bath, I am sure that it will not be in Pele's stew-pot, nor in the presence of a famished man-eater, hanging round and waiting with hungry expectancy to try the flavor of our corporeal substance.

Among the more curious specimens added to our collection at the crater of Kilauea is a singular substance, appropriately called by the natives "Pele's hair." It is a filamentous substance, resembling very closely spun glass—indeed its formation is due to a process very similar to that by which the latter is produced.

When molten lava has passed to the first stage of hardening, it is of a soft, waxy nature, and becomes ductile to a remarkable degree, considering its extreme brittleness when in a hardened state. It can be twisted and molded into any shape, and drawn out in long slender threads. When the lava

is thrown into the air by the constant play of the fiery jets in the burning lake, it becomes reduced in temperature so that in the separation of the particles when in this partially cooled condition, it is drawn out in threads or filaments of greater or less degree of fineness, just as a glass-blower spins his plastic lump of glass into long, delicate, silk-like fibres. As this substance, from its extreme tenuity, becomes very light, it floats in the air like a spider's web and does not descend with the heavier mass as it falls back into the lake, but is carried away by the force of the currents of air, sometimes to the distance of many miles from the crater.

To the windward of this crater, therefore, for several miles, this substance can be found, in many places completely covering the ground with its fairy gossamer carpet. The birds here sometimes, in the absence of better material, build their nests of it; and we were shown one that was composed entirely of this substance, which for delicacy of texture is all a feathered architect could desire.

Sending our guides forward with the mule train, laden with our collection securely packed, we mounted our horses, rode to the verge of the crater, looked once, twice, thrice at its glowing fires,

and regretfully bid adieu to Kilauea, resuming our journey to Hilo.

We stopped at a straggling native village about fifteen miles from the crater, where for the first time we observed the process by which the famous native Kapa cloth is made. The manufacture of this cloth is now confined to a very few persons, and so far as relates to these islands may soon be numbered among the lost arts. It is now produced only by aged people, who, as in our own country, have brought down into the present generation the customs and habits of the past.

This material, though in its general appearance it somewhat resembles woven fabrics, cannot properly be classed as a real cloth, being in fact a coarse, tough quality of paper. It is made from the inner bark of the Mamakie, or paper mulberry, which bears a very close resemblance to our own varieties of that tree. The bark, which is quite tough and highly fibrous, is cut into pieces of suitable size and soaked in water until it has become softened by its action. The bark is then laid on the smooth round surface of the trunk of an oheia or other tree, and beaten with a rectangular beater or club upon the faces of which is carved in lines the rude pattern which the fabric when

done is intended to contain as a sort of water lines.

One piece after another is thus laid on and joined or felted together, the mass spreading out into sheets of any desired size, and of a thickness quite uniform, resembling parchment. The cloth when complete affords a material of some durability, though it is more ornamental than useful, as it will not resist the effects of rain. It however at one time supplied to these people all the article of dress which they found necessary to wear, either from the demands of propriety, or the climate, or both. They are frequently quite prettily ornamented by painted designs and figures; and in former times, when the art was in its highest state, patterns were sometimes produced by the more dextrous and expert which were wonderful for their delicacy of texture, and such as was only the possible result of much skill, untiring patience and industry.

Another article which it was once their custom to largely produce, not only in these islands, but among almost all the southern oceanic groups, but now very nearly extinct here, was the celebrated intoxicating liquor called "awa." It is almost identical with the "kava" of the Tonga and Ta-

hitian islands, and manufactured in the same curious, disgusting manner.

As it is of the most highly intoxicating nature, and as its use formerly extended almost universally throughout the whole of Oceanica, arising in this region with a sort of spontaneity, it affords striking proof of the innate fondness of the human race for stimulants. Its manufacture and use in these islands is interdicted by the strongest legislative enactments, and punished by the severest penalties; yet it is almost impossible to wholly suppress it, as the natives find in the inaccessible fastnesses of the mountains both opportunity for its manufacture and security in its use; and such is their fondness for it that they will incur almost any risk in order to secure enough of it to develop a good square drunk.

It is made from the root of a species of pepper-plant, (*macropiper methysticum*) the close resemblance of which to the Ramie led us to imagine that it might be in some degree allied in nature to the Indian hemp from which the famous Hasheesh is produced. The method of its manufacture is very simple, strictly original, and not encumbered by any complicating processes of the chemist's art. The Kanaka being by nature a very sociable

creature and withal somewhat convivial, and as an "awa" debauch is the highest type of social enjoyment, its manufacture therefore becomes the occasion of rare social entertainment.

Surrounding a calabash of a size suited to the quantity to be produced, each member of the party takes a piece of the root and chews it until reduced to a soft, spongy, pulpy mass. This he throws into the calabash, and repeats the operation, each one in turn throwing in his well masticated *cud* until a sufficient quantity has been contributed to the common fund to meet the wants of the party.

While we cannot commend this practice for its perfect cleanliness, yet it will be seen that there is a familiarity, a pleasing sociability about it, that goes far towards redeeming it from a somewhat disgusting nastiness in some respects. After enough of the root has thus been chewed, water is poured over it, and it is then allowed to macerate for a short time. Some one of the party is then selected to give the finishing touch; and as it is regarded as an important function, the selection is made with great care. What the special qualifications are to enable one to officiate in an acceptable manner I am unable to say; but as we have seen

that cleanliness is esteemed as of the first moment, I presume the choice falls upon the one who should chance to have the cleanest hands. He takes the mass in his hands, kneads it thoroughly, and then squeezes it until quite dry, thus extracting carefully and fully all of the delicious, savory juices contained in it.

It is now ready to drink, and forms perhaps the most villainous decoction that the ingenuity of man, or rather want of ingenuity, ever concocted, or that ever passed the lips of an inebriate. A small amount is sufficient to produce the most deadly effects. When once thoroughly under its influence, the victim is transformed into a wild, furious maniac. It has all the worst features of all other intoxicants combined and intensified, without any of their good qualities. Its habitual use produces premature decrepitude, covering the unfortunate with disgusting sores.

We saw only one person under its influence during our stay on the islands, and very naturally mistook him for an escaped lunatic. It is one of the good effects of civilization that this custom has been in a measure suppressed.

On our return to Hilo we found the little steamer almost in readiness to sail for Honolulu; so after

stowing away our accumulated luggage and bidding a reluctant adieu to the many kind friends we had here found, we set out on what was really the first stage of our return. Our route lay along the eastern shore of Hawaii, rounding the northern cape of the island, and thence along a part of the western shore to the little town of Kauahai.

A part of this course we had gone over on our way here, but as it was during the night, we missed what we now found to be the most beautiful coast scenery we had met with. For eighty miles along the eastern shore, there arose a perpendicular black wall of lava, from 200 to 400 feet high, no doubt caused by the washing of the waves which here roll against the rocky wall, billow after billow, in ceaseless undulations. This coast wall is the sudden termination of the broad, gentle slope of Mauna Kea, over which and upward the densely laden trade breezes sweep and deposit their surcharged moisture in perpetual showers.

Hundreds of sparkling streams come rushing down from their source in the mountain side and plunge over this continuous precipice in silvery cataracts. To say that there are hundreds of these falls is strictly true, as in many places a score or more can be seen at one view, or within the space

of a mile or so. We touched but a brief time at Lahaina, where we met again our friends Gov. Kepana and Mr. Smith, with whom we spent so many pleasant hours during our former stay here.

We reached Honolulu at the end of two days' sail, and found to our inexpressible delight letters and papers in abundance from home, which we devoured with an avidity which might be expected after nearly two months' exile from home and the world of current news. As the steamer whose return from Australia we had to await was not yet due, we gave ourselves up to the delightful pastime of recruiting from our fatigue in the hospitable society of Honolulu, and daily horseback rides into the enticing country around.

We visited Mt. Tantalus, the pleasant valleys of Manoa, Halawa, climbed the rugged promontory of Coco Head, strolled along the snowy beach of Waikiki, when suddenly we were awakened from our pleasant dream by the unwelcome news that the steamer had arrived, and at last the time had come for us to quit these scenes of more than earthly beauty. The sails are unfurled, the slow heavy beating of the engine measures by its dull, monotonous throb each fleeting moment that binds us to this paradise, and ere we have realized the

truth we find, alas! that we must bid farewell—but as I trust not forever—to this lovely land.

I cannot say that "the end" shall be written under this, the most pleasant page of my life, without an expression of the deepest, truest regret and sorrow in parting with one whose kind attentions, whose generous efforts contributed so largely to the pleasure, the happiness we experienced in these islands. As the boat was leaving the wharf at San Francisco, on our departure for the islands, we noticed a tall, fatherly gentleman whose courtesy and cordiality, whose modesty of deportment drew and fixed our attention. We soon learned that he was a resident of the islands, and was returning from what was perhaps his last visit to his native country. It was the Rev. Mr. Castle, one of the first missionaries to the islands, who had been a resident there for nearly forty years, and for many years Secretary of the Board of Foreign Missions. He is now quite an aged man, but with a heart fresh and youthful in its tenderness and kindness.

We very soon became acquainted, and so charmed were we with his gentleness of manner, his goodness of heart, that each succeeding morning found us looking with more impatient

eagerness for his appearance—he who by word and act added so much to our comfort and happiness. On our arrival at Honolulu, we found in his constant endeavors to aid us, in the friendly offices that betokened a heart deep and full of charity and sympathy, fresh cause to remember and revere him as one of the rarest of Christian gentlemen. What more can we say of one combining all those virtues that constitute a true gentleman and the graces that make a real Christian, but to add the regret that this selfish world is not peopled with such as he.

But alas! his virtues stand out all the more conspicuous, like his own sunny isles, (visions of which haunt me yet) whose skies shine all the brighter, and whose landscapes smile all the sweeter, because they stand alone in the glories of their perfect, unapproachable beauty and splendor, in a world whose contending elements, closing in the perpetual strife of endless disorder, the inscrutable laws of nature have wrought into a mysterious whole.

THE END.

APPENDIX.

Pronunciation of Hawaiian Terms.

In the Hawaiian language the vowel sounds are similar to those of most of the continental languages of Europe, being also uniform and unvarying except as to the duration of their utterance. *A* has the sound of *a* in *father*; *E* has the sound of *a* in *fate*; *I* has the sound of *e* in *me*; *O* has the natural sound of *o* in *go*; and *U* that of *oo* in *boot*.

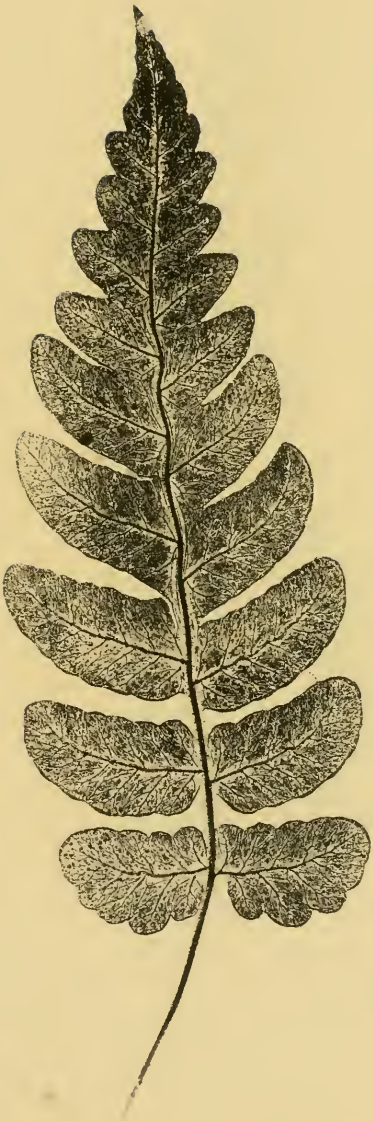
The following is a list of the Hawaiian terms and names which have been used in the foregoing chapters, with their English pronunciation as nearly as can be given:

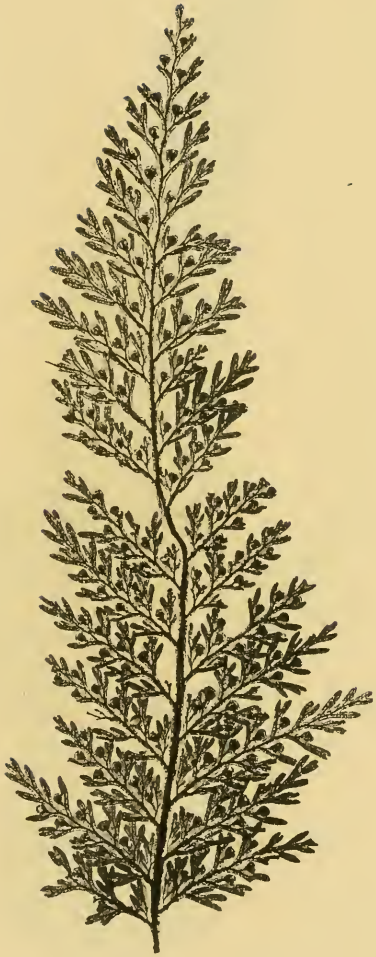
Ainapo—Ah-ee-nah-po'
Awa—Ah'wah
Hawaii—How-ah'ee
Hilo—Hee'lo
Hualalai—Hoo-ah-lah-lah'ee
Haleakala—Hah-lee-ack-ah-lah'
Halemaumau—Hah-lee-mow' oo-mow-oo
Honokua—Ho-no-koo'ah
Halawa—Hah-lah'wah
Holoku—Ho'lo-koo
Iao—Ee-ah'o
Kauai—Kow-aw'ee
Kahoolawe—Kah-ho-lah'wa
Kauahai—Ko-ah-hah'ee
Kappapala—Kah-pop'a-lah
Kailua—Kah-ee-loo'ah
Kau—Kah-oo'
Kilauea—Kee low-way'ah
Kukui—Koo-koo'ee
Kona—Ko'nah
Kealekakua—Kay-ah-lay-kah-koo'ah

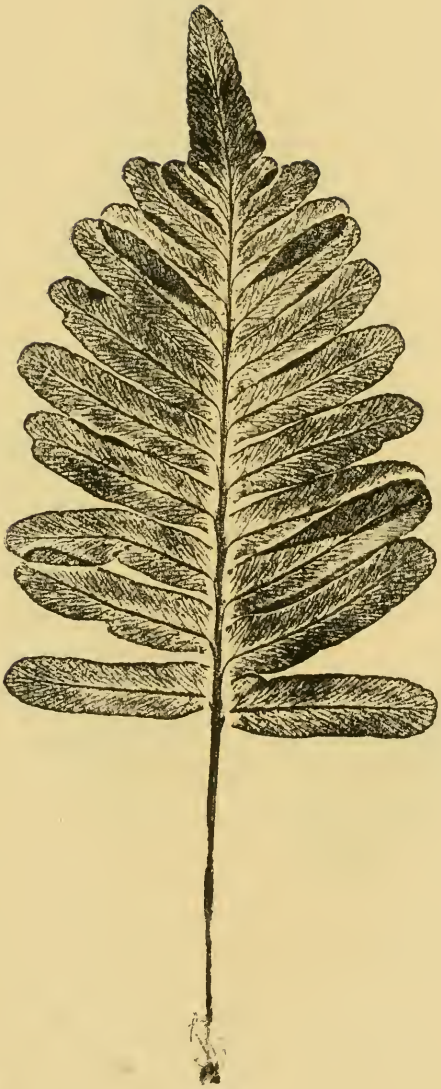
Koa—Ko′ah
Kou—Ko-oo′
Kamehameha— Kah-may′ah-may-ah
Kalakaua—Kah-lah-kow′ah
Kapena—Kah-pay′nah
Kapa—Kah′pah
Kanaka—Kah-nah′kah
Lanai—Lah-nah′ee
Lahaina—Lah-hy′nah
Lauhalla—Lah-oo-hal′lah
Lunalilo—Loo-nah-lee′lo
Maui—Mow′ee
Molokai—Mo-lo-kah′ee
Mokawau—Muck-ah-wah′oo
Mauna Loa—Mow′nah-Lo′ah
MaunaKea—Mow′nah-Kay′ah
Mokuaweoweo — Muck-oo-ah-way′o-way-o
Mamakie—Mah-mah′ka
Manoa—Mah-no′ah
Niihau—Nee-ee-how′oo
Ninoli—Nee-no′lee
Nuanu—Noo-ah′new
Oahu—O-waw′hoo
Oheia—O-hee′ah
Oloalu—O-lo-ah′loo
Puna—Poo′nah
Poi—Po′ee
Pulu—Poo′loo
Pele—Pay′lay
Pahoehoe—Pah-ho′a-ho-a
Palli—Pah′lee
Taro—Tah′ro
Tabu—Tah′boo
Ulapalakua — Oo-lah-pal-ah-koo′ah
Wailuku—Wy-loo′koo
Waikiki—Wy′kee-kee
Waihinu—Wah-ee-hee′noo
Wainanalai—Wah-ee-nah-nah-lah′ee
Wiliwili—Wee′lee-wee-lee

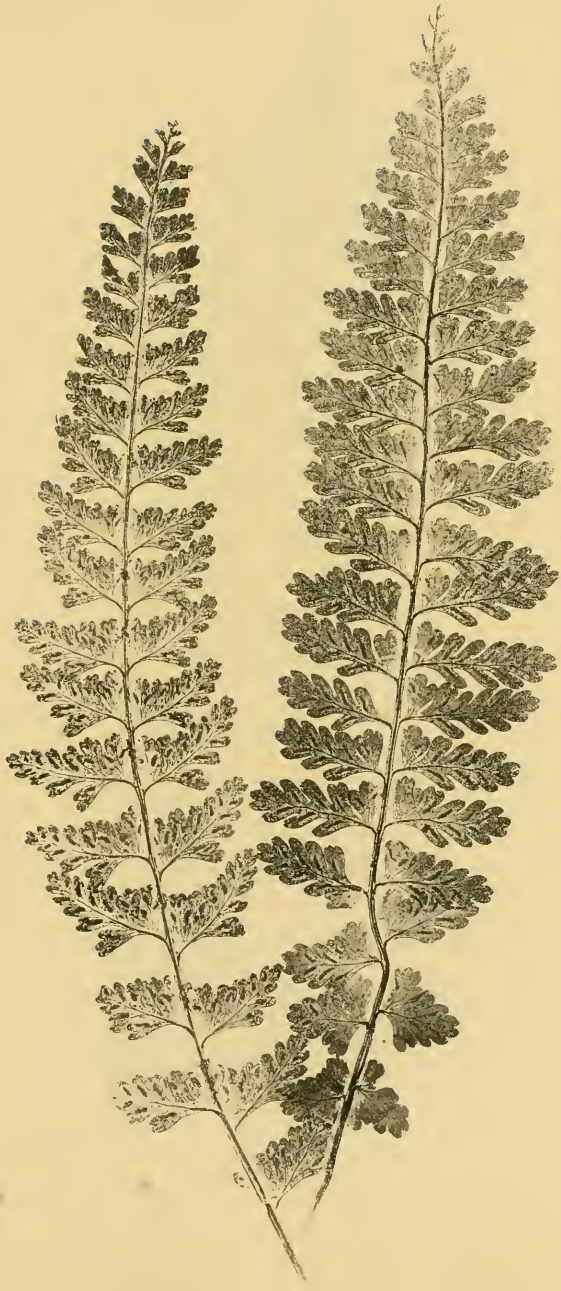
NOTE.

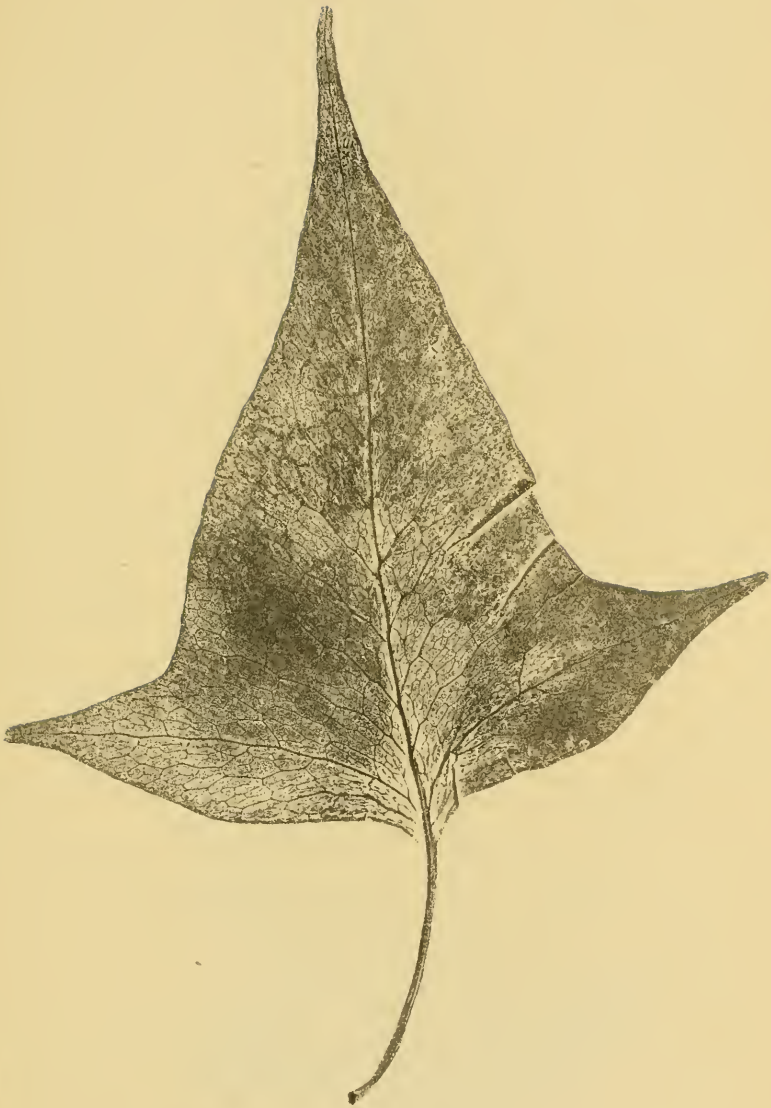
For the following collection of prints from specimens of some of the many beautiful varieties of ferns found on the Hawaiian Islands, I am indebted to the diligent and skillful labors of my wife, who with great care transferred directly from the specimens the impressions contained in the remaining pages of this volume.

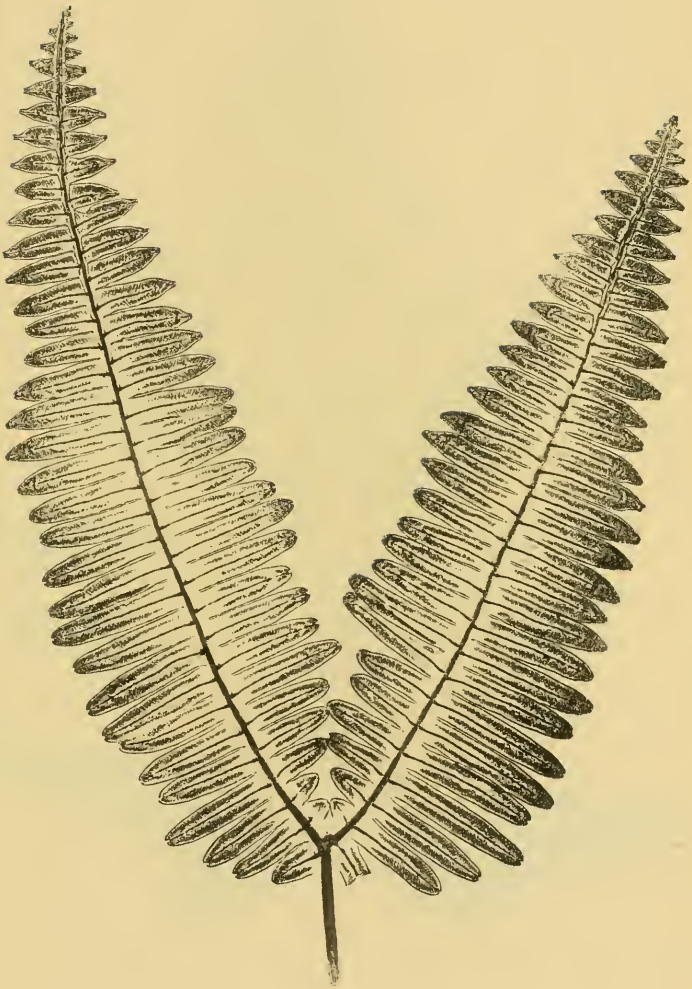


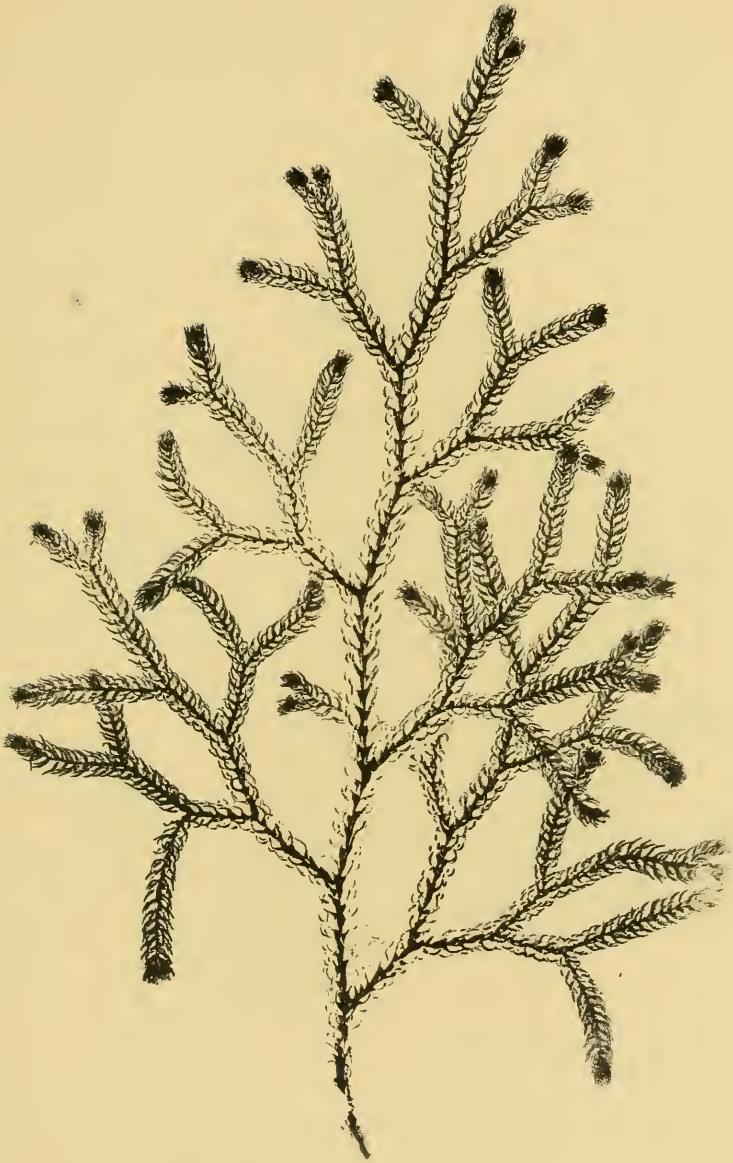












LIBRARY OF CONGRESS
0 017 064 358 6